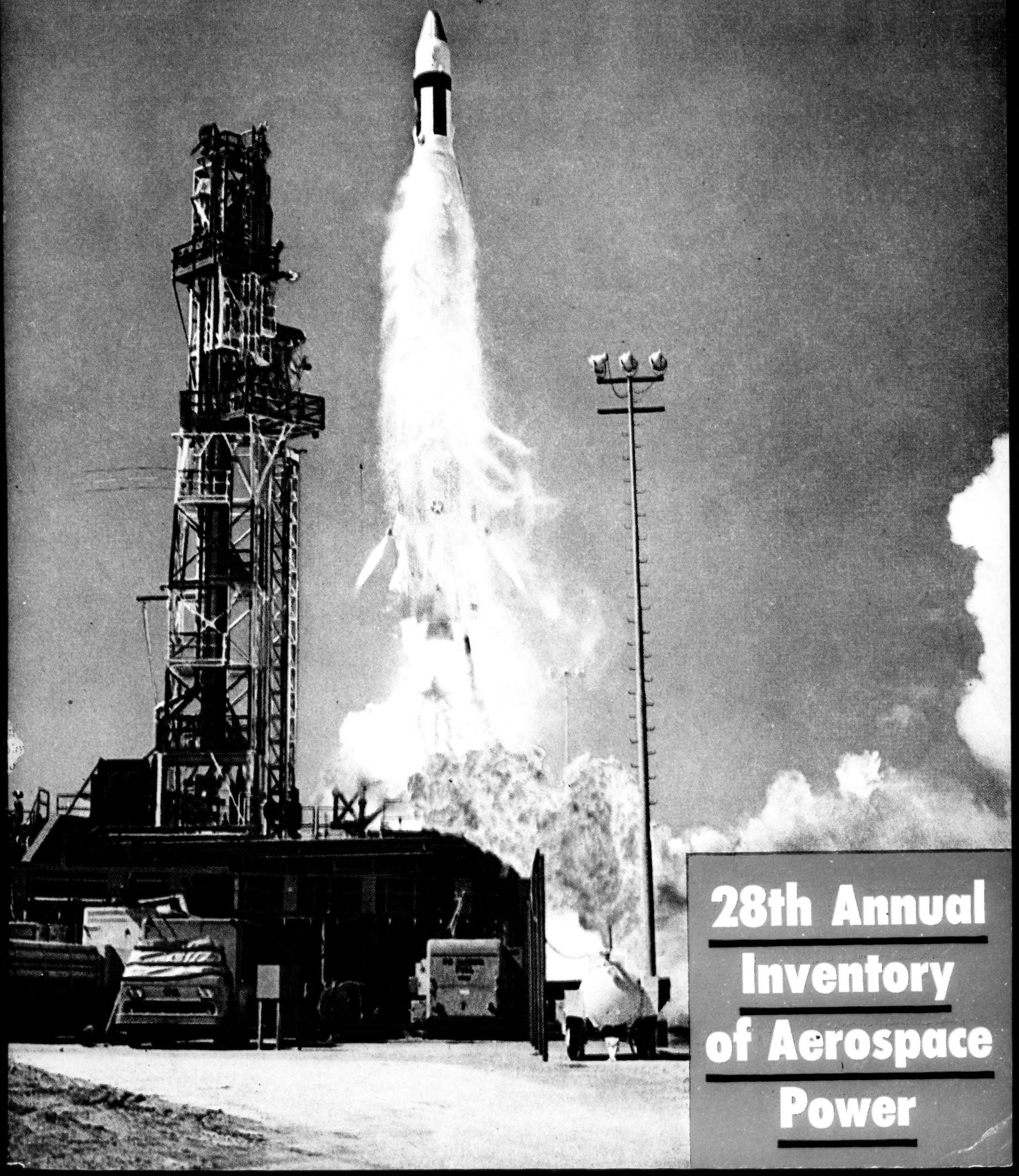
ISSUE $2.00

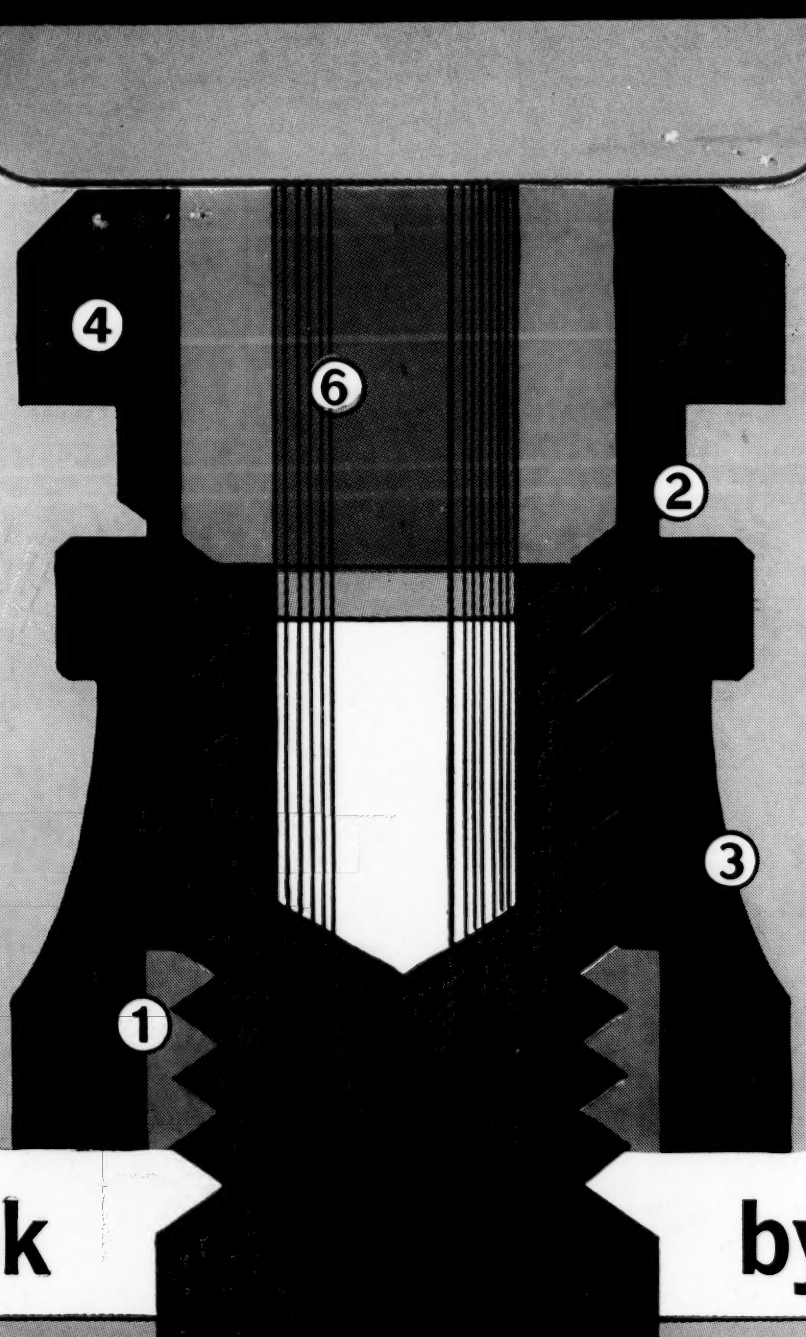
Aviation Week

and Space Technology

A McGRAW-HILL PUBLICATION



28th Annual Inventory of Aerospace Power



*Hi-Lok by VOI-SHAN

Consistently controlled preload, minimum size and weight, plus speed of installation are outstanding advantages of the new Hi-Lok fastener now being produced by Voi-Shan. The Hi-Lok is the result of a design effort to provide an advanced fastener system incorporating as many desirable features as possible, with the greatest adaptability, in one product. Hi-Lok is driven from one side of the work, thereby saving in installation costs. Power tooling in use adds to time savings. Accurate, automatic torque control is incorporated by means of a closely controlled shear groove in the Hi-Lok collar. Available in a wide range of sizes and material combinations. The Hi-Lok is produced with the accepted Voi-Shan precision workmanship and quality control for maximum performance. Write for further details and specifications.

1 Grip coverage: 1/16 inch min. Counterbore absorbs material thickness variation.

2 Progressive tightening: Hi-Lok cannot over-torque. The driving section separates at pre-established torque level.

3 Weight savings: Hi-Lok is as much as 39% lighter than conventional AN bolt, nut, washer combination.

4 Clearance: Hi-Lok pin head and collar diameters allow smaller wrench clearance. The "torque-off" hex-wrenching section projects to allow small tool accessibility.

5 No recess in head: Improves aerodynamic qualities. 100° countersunk, close-tolerance, shear head style and sealing compound are used in wet wing assemblies.

6 Silent installation without vibration: Automatic and high speed power tool use is fast and quiet. Hand tool installation and removal is easy and permits re-use of the Hi-Lok pin.

VOI-SHAN MANUFACTURING COMPANY
A Division of Voi-Shan Industries, Inc.
8463 Higuera Street, Culver City, California

VSI

* Trademark Registered & Patent Applied For

AVIATION WEEK and Space Technology

March 13, 1961
Vol. 74, No. 11

PUBLISHER.....Robert W. Martin, Jr.
EDITOR.....Robert B. Hotz

MANAGING EDITOR.....William Gregory
TECHNICAL EDITOR.....David A. Anderton
EUROPEAN EDITOR.....Cecil Brownlow

BUREAU CHIEFS

WASHINGTON.....Evert Clark
LOS ANGELES.....Irving Stone
DALLAS.....Erwin J. Bulban

DESK EDITORS.....Craig Lewis, John A. Nammack, Harry Raven, Arnold Sherman
AVIONICS EDITOR.....Philip J. Klass
ASSISTANT.....Barry Miller
TRANSPORT EDITOR.....L. L. Doty
ASSISTANTS Glenn Garrison, Robert H. Cook, David H. Hoffman
ENGINEERING.....Michael Yaffee, Russell Hawkes, William S. Reed
SPACE TECHNOLOGY....Edward H. Kolcum, George Alexander
MILITARY EDITOR.....Larry Booda
BUSINESS FLYING.....Erwin J. Bulban, Herbert J. Coleman, Andrew A. Keil
CONGRESS.....Ford Eastman, Katherine Johnsen
EQUIPMENT.....Barry Tully
ART EDITOR.....Lawrence J. Herb
ASSISTANT.....Karl G. Neuman
EDITORIAL PRODUCTION.....Frank Miazga
ASSISTANT EDITORS.....Elizabeth M. Hein, Edith Walford
EDITORIAL ASSISTANTS.....Ward Wright, Marjorie Todd
LIBRARIAN.....Theresa V. Maggio
ADVERTISING SALES MANAGER E. P. Blanchard, Jr.
PROMOTION & RESEARCH MGR..C. C. Gersna
EUROPEAN MARKETING DIRECTOR Fulvio Piovano
RESEARCH & MARKETING..Rosalie Christesen
BUSINESS MANAGER.....J. G. Johnson
CIRCULATION MANAGER.....T. J. Lucey
ASST. BUSINESS MANAGER...W. V. Cockrel
PRODUCTION MANAGER.....F. A. Dube

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Printed at Albany, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher. Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

Available only by paid subscription. Publisher reserves the right to refuse non-qualified subscriptions. Subscriptions to Aviation Week solicited only from persons who have a commercial or professional interest in aviation, including missiles and space technology. Position and company connection must be indicated on subscription orders forwarded to address shown in box below.

Single copies 75¢. This issue $2.00, no extra charge to subscribers. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

Our primary aim is to provide subscribers with a useful and valuable publication. Your comments and suggestions for improvement are encouraged and will be most welcome. The publisher, upon written request, agrees to refund the part of the subscription price applying to the remaining unfilled portion of the subscription if service is unsatisfactory.

Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office. ©Copyright 1961 by McGraw-Hill Publishing Co., Inc. All rights reserved. Cable Address: "McGraw-Hill New York." Publications combined with AVIATION WEEK and SPACE TECHNOLOGY are AVIATION, AVIATION NEWS, AIR TRANSPORT, AERONAUTICAL ENGINEERING and AIRCRAFT JOURNAL. All rights to these names are reserved by McGraw-Hill Publishing Co.

Subscribers: Send correspondence and change of address to Fulfillment Manager, Aviation Week, 330 West 42nd Street, New York, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address, including postal zone number. Enclose recent address label if possible. Allow one month for change to become effective.

Postmaster: Please send form 3579 to Fulfillment Manager, Aviation Week and Space Technology, 330 West 42nd Street, New York 36, N.Y.

← Circle Number 4 on Reader-Service Card

SUPERIOR ACCURACY

in heat controls

for jet windshields

Convair 880 jet airliners are first to use new, advanced design anti-fogging, anti-icing heat control systems developed by Magnetic Controls Company.

Windshield icing and fogging problems are considerably more complex for jet airliners, compared with those encountered by piston engine planes. With jet travel, faster speeds, higher altitudes, plus greater extremes in temperatures and atmospheric pressures, many new problems develop. Magnetic Controls proportional heat control systems have helped to solve these problems for Convair 880 jets. The Magnetic Controls systems offer four distinct advantages:

- **Automatic compensation for windshield aging.**
- **Ultra-reliable, fully static design.**
- **Elimination of thermal shock for longer windshield life.**
- **Superior accuracy — proportional plus integral control.**

For complete information about this system and how it may help you obtain precise, accurate heat control for many applications, write or phone Magnetic Controls Company today.

MAGNETIC CONTROLS COMPANY

6413 CAMBRIDGE STREET • MINNEAPOLIS 26, MINN. • WEst 9-4691

Heat Control Systems • Static Inverters • Voltage Monitoring Systems

Circle Number 5 on Reader-Service Card

Building block concept for very large solid boosters successfully demonstrated

United Technology Corporation has successfully completed the firing of a series of flight-weight conical, segmented solid propellant rockets – one phase of a study being conducted for NASA.

The use of conical segments makes possible the fabrication of very large solid rockets at lower cost, significantly reduces handling and manufacturing problems.

With the successful demonstration of UTC's building block concept, current technology can now provide solid booster thrusts exceeding any known to exist in the world.

UNITED TECHNOLOGY CORPORATION

A subsidiary of United Aircraft Corporation

Capability backed by four decades of propulsion experience

P. O. Box 358, Sunnyvale, California

Conical, segmented solid propellant rocket pictured during one of a series of successful firings at UTC's multi-million-dollar Development Center in the San Francisco Bay Area. The UTC rocket, with minor adaptation, is ready for immediate use as an operational vehicle.

● CONTENTS

Aviation Week and Space Technology

Volume 74
Number 11

March 13, 1961

TWENTY-EIGHTH ANNUAL INVENTORY OF AEROSPACE POWER

● AEROSPACE FORECAST

Budget Shifts May Spur Aerospace Sales.. 68

● AEROSPACE PROCUREMENT, RESEARCH FUNDS....70

● MILITARY....71

USAF Seeks Combat Role in Space..... 73
Navy Builds Polaris, Jet Support Forces... 78
Army Renews Drive for Zeus Anti-ICBM... 82
NATO Divided on Weapons, National Roles 89
Sino-Soviet Threat Grows..... 92

● SPACE TECHNOLOGY....105

Russia Still Holds Four-Year Space Lead..107
Services Vie for Larger Space Role.....115
Booster Limitations Delay U. S. In Space..118

● MISSILES....123

Service Use Modifies Missile Concepts.....125
Economic Problems Color Missile Future..135

● AIR TRANSPORT....143

Costs, Jet Competition Squeeze Trunks....145
U. S. Traffic Share Continues to Decline..151
Local Carriers Win New Subsidy Formula..155
U. S. Aircraft in Air Transportation.....160
Trunk, All-Cargo Line Showdown Looms..165
Federal Airport Fund Outlook Improves..169
Equipment Problems Slow Aeroflot Gains..173
World Airlines Feel Full Jet Impact.....178

● SPECIFICATIONS....181

U. S. Military Aircraft 183
U. S. Missiles 185
U. S.-U.S.S.R. Satellites and Space Probes..187
U. S. Space Vehicles and Rockets.....189
U. S. Civil and Military Transports.....191
U. S. Gas Turbine Engines.....192
U. S. STOL and VTOL Aircraft.....194
U. S. Civil and Military Rotary-Wing....195
U. S. Personal and Business Aircraft.....197
Leading Foreign Gas Turbines.....198
U. S. Reciprocating Engines 201
Foreign Rotary-Wing Aircraft.....203
U.S.S.R. Military and Civil Aircraft.....205
Leading Foreign Aircraft Military and Civil.206

R&D Costs Temper Financial Outlook....215

● AVIONICS....223

Avionics Competitive Squeeze Tightens....227
FAA Prepares to Test Modernized ATC....229
Microelectronic Research Effort Grows....239

● HELICOPTERS....247

Missions Expand for Vertical Flight.....249

● BUSINESS FLYING....257

Business Flying Feels Recession Pinch.....259
Europe to Compete for Lightplane Sales..265

● FOREIGN....271

Britain Eyes Competitive Project Cuts....273
French Score in Drive to Widen Market...280
Italy Benefits in F-104, G.91 Program....286
Japanese Await F-104 Start.....288
Recession Spurs Canadian Defense Debate..289
Germans Weld Multi-Nation Defense Team.293
East Europe Pushes Aircraft Exports.....295

● NEWS OF THE WEEK....303

● COVER: USAF-Lockheed Midas Reconnaissance Satellite

Kennedy Budget Shifts May Accelerate

Aerospace industry can expect a slightly rising curve in gross sales to nearly $13 billion during 1961, with the possibility of a sharper rise in the last half based on moderately increased military budgets anticipated when the Kennedy Administration submits its amendments to the Fiscal 1962 budget requests sent to Congress last January by the outgoing Eisenhower Administration.

Although the new shape of the Kennedy Fiscal 1962 budgets for aerospace activities probably will not be clearly visible until mid-April or early May, the anticipated changes will most likely add about $2 billion to the Fiscal 1962 budget of the Eisenhower Administration—with major emphasis on project changes rather than on a large total dollar increase.

The Fiscal 1962 budget submitted in January already showed trends toward the modest increases in the aerospace budget that are likely to continue during the next few years despite continued efforts to seek adequate methods of arms control with the Soviet Union. The original budget expenditure plans give a general indication of how the aerospace market will develop for 1961. They include:

- **$5.9 billion for military aircraft,** split into $4.1 billion for the Air Force; $1.7 billion for the Navy, and $156 million for the Army. This includes engines, airborne avionic systems and ground support equipment.
- **$4 billion for missiles,** split into $3 billion for the Air Force; $500 million for the Navy, and $500 million for the Army. This includes rocket engines, guidance packages, automatic checkout equipment and other ground support equipment, but not missile base construction.
- **$1.5 billion for space research and development,** with $829 million for NASA out of its total $1.1 billion budget request and about $700 million for USAF, Navy and Army activities from the total $4 billion military research and development budget request.

Commercial aviation sales including jet transports, executive aircraft, helicopters and their related equipment should top $2 billion for the second consecutive year, with the beginnings of a small commercial market appearing in space through booster rocket sales to foreign countries joining the NASA international cooperation program and for the commercial communications satellite systems.

Aircraft manufacturers can look forward to initiation of some key programs that should lay foundations for major business during the next five years and counter the trend of recent years when almost all new programs involved missiles or space projects. These include the USAF SS-476L turbofan cargo transport, developed jointly to meet both military and commercial requirements; the tri-service VTOL transport program; the STOL tactical fighter program, and the LOH helicopter program.

Missile market will broaden to include a new generation of solid fueled, extremely mobile ICBMs and IRBMs incorporating basic propulsion, guidance and warhead state of the art advances over the Polaris and Minuteman types. Emphasis on quantities of rocket boosters and payloads to establish and maintain operational space systems—for both military and civil use such as reconnaissance, electronic intelligence, communications, weather reporting and precise navigation aids—will make possible much larger production runs in this field than have been possible during the early development phases and the initial limited deployment of Atlas and Titan. In addition, a substantial development requirement is anticipated for the extremely large space boosters required for the next generation of space vehicles.

Avionics is still riding the crest of a fantastic wave of technological developments and an increasing share of the total aerospace market. But it is beginning to feel an economic pinch from the shift to fewer but more complex and demanding weapon systems that have shorter production runs and from increasing competition as former customers in the airframe industry have plunged into avionics and former component manufacturers, spurred by solid state developments, have turned toward systems development. The tide of basically new technical developments in the avionics field is still running so high that it is difficult to forecast at this time just where it will stabilize and provide a more profitable economic

Aviation Week and Space Technology

Slight Rise in Aerospace Sales

foundation for the industry than is currently in sight.

With the bulk of its market controlled by government agencies, the aerospace industry still faces a number of unsolved problems that have combined in recent years to force a drastically narrowing profit margin in the face of increased sales. These include punitive administration of renegotiation laws, a growing demand from the government that industry finance a larger portion of its research and development activity and a general failure of government procurement policies and procedures to be modernized to fit the technologies with which they are now required to cope.

Air transport industry is facing a tough year as it fights to develop traffic increases required to fill the increasing rows of seats in its burgeoning jet transport fleet. Airline seat capacity will increase by 23% during 1961, while the traffic increase is forecast for only 4%. Initial public enthusiasm for the turbojet transport has not yet been translated into the significant scale of broadened market that the new equipment requires for profitable operations. Traffic growth during 1960 was only 4%, compared with an annual growth rate averaging about 14% during the previous five years, indicating serious problems in solving the overcapacity problem created by the advent of the jet transport in fleetwide quantities.

More airline mergers are in prospect as a partial solution to this problem, but Civil Aeronautics Board policy will be carefully tailored to avoid elimination of competition on specific route patterns.

Basic modernization of the air traffic control system to provide regularity of service and increased operational capacity is the biggest hurdle facing the air transport industry and the Federal Aviation Agency in generating additional traffic.

Business flying will level off during 1961 from it post-war peak sales of 1960, with the impact of the economic recession, exerting a dampening effect on its domestic markets, countered by a 50% broadening of its export market. Retail values of factory deliveries will probably slide below the 1960 record $200-million mark. Business flying aircraft manufacturers are anticipating a general business upturn in the summer that they hope will reduce their inventories, piled up during the final quarter of 1960 and the early months of 1961.

Service bases for the executive plane fleet are experiencing a definite increase in fuel and maintenance sales as a result of an increasingly high utilization rate of the U. S. business aircraft fleet. New executive models in the gas turbine-powered class are under development by a variety of manufacturers, with some appearing in the 1961 sales volume.

Primary problems of the aerospace industry for 1961 and the ensuing years will be largely dependent on the basic policies formulated by the new Administration of President John F. Kennedy in its first six months of office. Some of these policies will have little effect on the 1961 business picture because of the lead time in translating decisions into federal appropriations and contracts with industry. However, the basic policies that are certain to emerge in the spring and summer will provide the clues as to what shape the aerospace industry can be expected to take during the next four years.

In addition to these policy influences, there are strong indications that the requirements of the cold war are likely to increase, with tension areas ranging from logistic support of United Nations operations in the Congo to brush fire war in Laos. Any strain of this sort, particularly simultaneous crises in widely separated parts of the globe, are likely to force an increase in capability in key military areas beyond anything currently contemplated.

Whether the U. S. will formulate a policy aimed at establishing clear international supremacy in space technology is another significant question that the Kennedy Administration has not yet answered. This year will require an extremely close watch by the aerospace industry on the newly hatching policies of the Kennedy Administration, first as to their intent and next as to their scope.

Robert Hotz

AIRFORCE

BILLION DOLLARS

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

EXPENDITURES

AIRCRAFT

MISSILE

RDT&E

NAVY

EXPENDITURES

AIRCRAFT

MISSILE

RDT&E

ARMY

EXPENDITURES

AIRCRAFT

MISSILE

RDT&E

1961 NEW OBLIGATIONAL AUTHORITY

1962 EXPENDITURES

FEDERAL AVIATION AGENCY

1000 900 800 700 600 500 400 300 200 100

MILLION DOLLARS

R&D

N.A.S.A.

MILLION DOLLARS

O.S.D.

1500 1400 1300 1200 1100 1000 900 800 700 600 500 400 300 200 100

MILLION DOLLARS

BOEING B-52 WITH DOUGLAS SKYBOLT MISSILES

Air Force Pushes Shift to Missiles, Space

By Larry Booda

Air Force, aggressively pursuing a course designed to carry it from the manned aircraft era through ballistic missiles to an assured military mission in space, is having to cope with a multiplicity of problems stemming from the shifting weapon system emphasis.

While the strategic mission is undergoing rapid change, advancing technology is forcing reluctant air supremacy advocates within the service to leave their familiar element and contend with the strange new world of missiles. And in this period of transition, USAF is having to look forward to the still more unusual proposals aimed at fulfilling a military mission in space. Although limited by current policy directives to defensive military development for space, the Air Force Air Research and Development Command has plans for developing retaliatory satellite and other systems.

Thus the Air Force, which has encouraged the use of "aerospace" in all descriptions of its activities and plans, is trying to take care of the present and the near future, while at the same time assuring its continued existence in the nation's defense picture in the late 1960s and the 1970s.

With USAF already commanding 43% of the federal budget, it holds little hope of increasing its slice. To hold its own now and to assure its future, its arguments within the Defense Department and the Administration, and to Congress and the public include these key facets:

• **Continue emphasis on the strategic** deterrent posture. Air Force must contend here with the problem that has existed since the formation of the Strategic Air Command—the task of selling protection when the concrete results of heavy expenditures are seen only by those who live close to air bases.

Potent opposition from groups opposed to any use of nuclear weapons also must be contended with.

• **Enhance the aircraft-borne nuclear** deterrent power. USAF has continued to press hard for money to finance an airborne alert for SAC heavy bombers. So far, only token funds have been provided for preparing for such an alert. An actual alert would wear out aircraft and require training, extra crews and maintenance to such an extent that Air Force has not been able to justify the costs. The move is intended as a stopgap during the so-called missile gap period. However, the Eisenhower Administration denied any missile gap and based its policy on over-all "deterrent power."

The policy of the Kennedy Administration is still being formed.

• **Improve penetration capability for SAC** bombers. Russia apparently has embarked on a crash program to provide both supersonic fighter and surface-to-air missile protection against manned aircraft. The Air Force says the answer lies in the standoff missile. The air breathing Hound Dog missile is in operation, and it is to be followed by the Skybolt air-launched ballistic missile.

Skybolt is designed as a penetration aid for B-52 bombers beginning in the 1964-65 period. It has become controversial because some elements within the Air Force believe surface-to-surface ballistic missiles will have been improved and produced in sufficient quantity by that time to eliminate the need for manned bombers for the initial strike mission. Diplomatic repercussions developed because Great Britain is depending on Skybolt as a penetra-

Air Force Active Aircraft Inventory

(End of Fiscal Year)

1958	22,578
1959	20,890
1960	18,712
1961	16,941*
1962	16,080*

*Planned

SUPERSONIC B-58 HUSTLER bomber is shown in midair refueling operation with Strategic Air Command KC-135 turbojet tanker. Two Convair B-58s recently established six world speed records over a 1,000-km. closed course (AW Jan. 23, p. 39). In an earlier three-hour test flight with midair refueling, a SAC B-58 flew faster than Mach 2 for over 78 min. (AW Oct. 31, p. 23).

Air Force Aircraft on Order Fiscal 1961

AIRCRAFT TYPE	POPULAR NAME	MANUFACTURER
B-52H	Stratofortress	Boeing
B-58	Hustler	Convair
F-105D	Thunderchief	Republic
C-130B, C-130E	Hercules	Lockheed
KC-135	Stratotanker	Boeing
C-135	.....	Boeing
T-37	.....	Cessna
T-38	.....	Northrop
T-39	Sabreliner	North American
T-40	JetStar	Lockheed
H-34B	Huskie	Kaman

Air Force Missiles on Order Fiscal 1961

MISSILE	MISSION	MANUFACTURER
Minuteman	ICBM	Boeing
Atlas	ICBM	Convair
Titan	ICBM	Martin
Thor	Space Booster	Douglas
Hound Dog	Air-to-Surface	North American
Quail	Air-to-Surface	McDonnell
Bullpup	Air-to-Surface	Martin*
Mace B	Surface-to-Surface	Martin
Bomarc	Surface-to-Air	Boeing
Falcon	Air-to-Air	Hughes
Sidewinder	Air-to-Air	Philco*
Genie	Air-to-Air	Douglas

*Purchased through Navy

tion aid for its Vulcan heavy bomber and the Eisenhower Budget for Fiscal 1962 provided no new funding for Skybolt. Fiscal 1961 funds were spread over two years, with assurance that the program will be continued. But it still hangs in the balance, awaiting the Kennedy reappraisal of the defense posture.

• **Retain manned capability** in the aerospace weapons mix. Air Force is strongly supporting continued development of the Mach 3 North American B-70 bomber as a successor to the B-52. The Dyna-Soar hypersonic glider is in the design stage as a research vehicle, but it also holds promise as the basis for a future weapon system, and ARDC is studying manned space vehicle concepts more advanced than Dyna-Soar.

• **Press for operational status** as soon as possible for a sufficient number of intercontinental ballistic missiles. Definition of a "sufficient" number of missiles is a matter of controversy within the Defense Department, with the Navy raising the strongest objection to the Air Force philosophy of having enough residual power to survive an initial attack and strike a counterblow. Navy arguments center around the "finite deterrent" philosophy, which says that enough power to destroy Russia is sufficient and that any "overkill" capability is surplus.

• **All-out fight to sell the Air Force** concept of missile defense. This includes fighting the Army's Nike Zeus anti-missile missile system, now in the development stage. The Air Force concept involves intercepting enemy missiles in their powered phase by use of satellites which would detect missiles after they rose above the cloud layer and then fire anti-ICBM missiles to intercept and destroy them. The Army contends that its Nike Zeus could, with funding for concurrent production, be ready by 1965. However, Army claims that a satellite intercept system would not be ready until sometime in the 1970s.

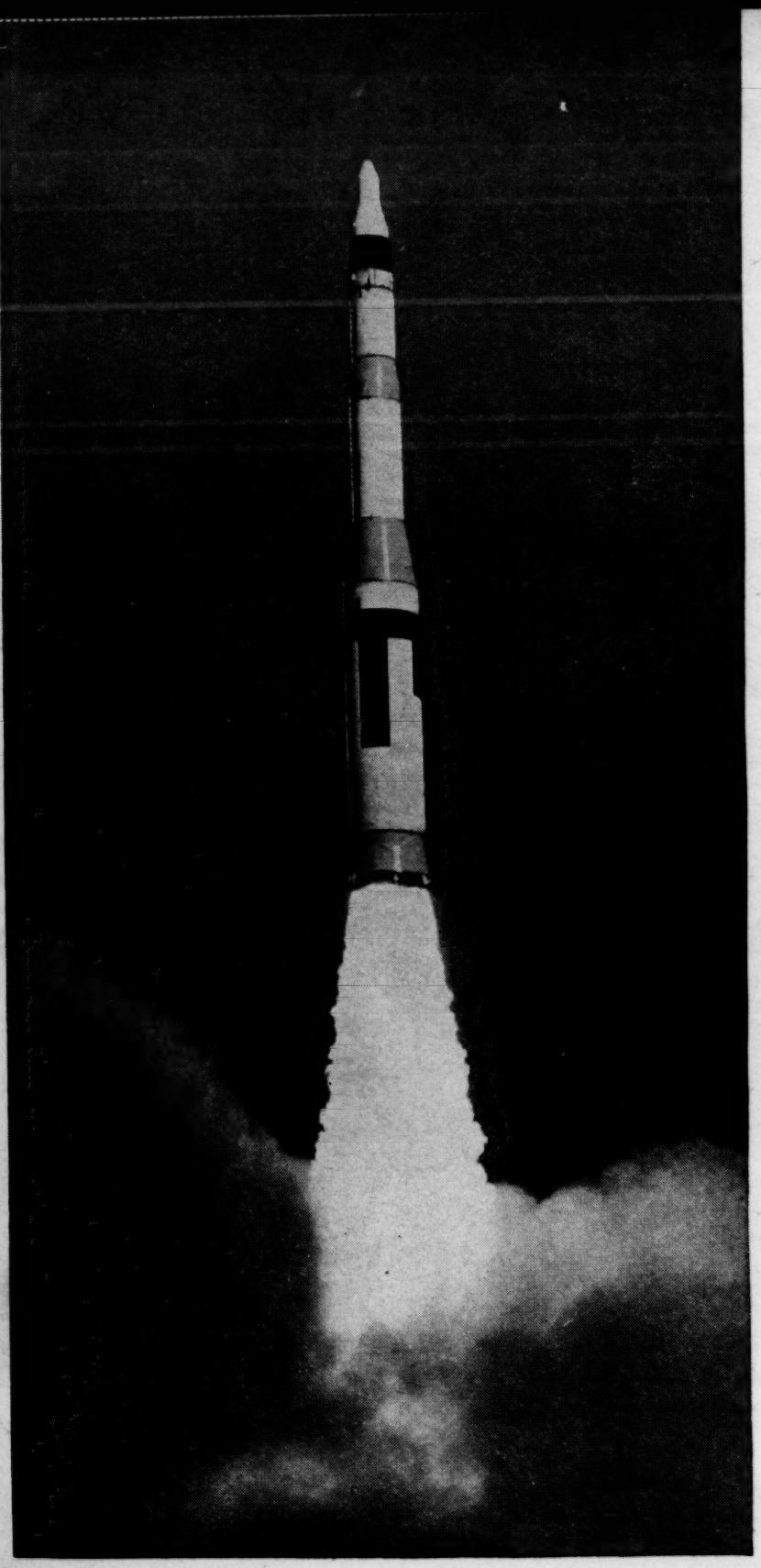
At stake are long-range funds. Air Force feels that, if a commitment is made to one system, its satellite concept has less chance to be funded for rapid development. Navy also is in the picture with its "space mine" or Early Spring concept. The Early Spring concept would have a vertical probe explode a cloud of shot in the path of a satellite.

• **Drive to have all military space activities** placed under control of the Air Force. An order signed by former Secretary of Defense Thomas S. Gates last fall, which placed all space tracking and detection under the Continental Air Command-North American Defense Command was a step.

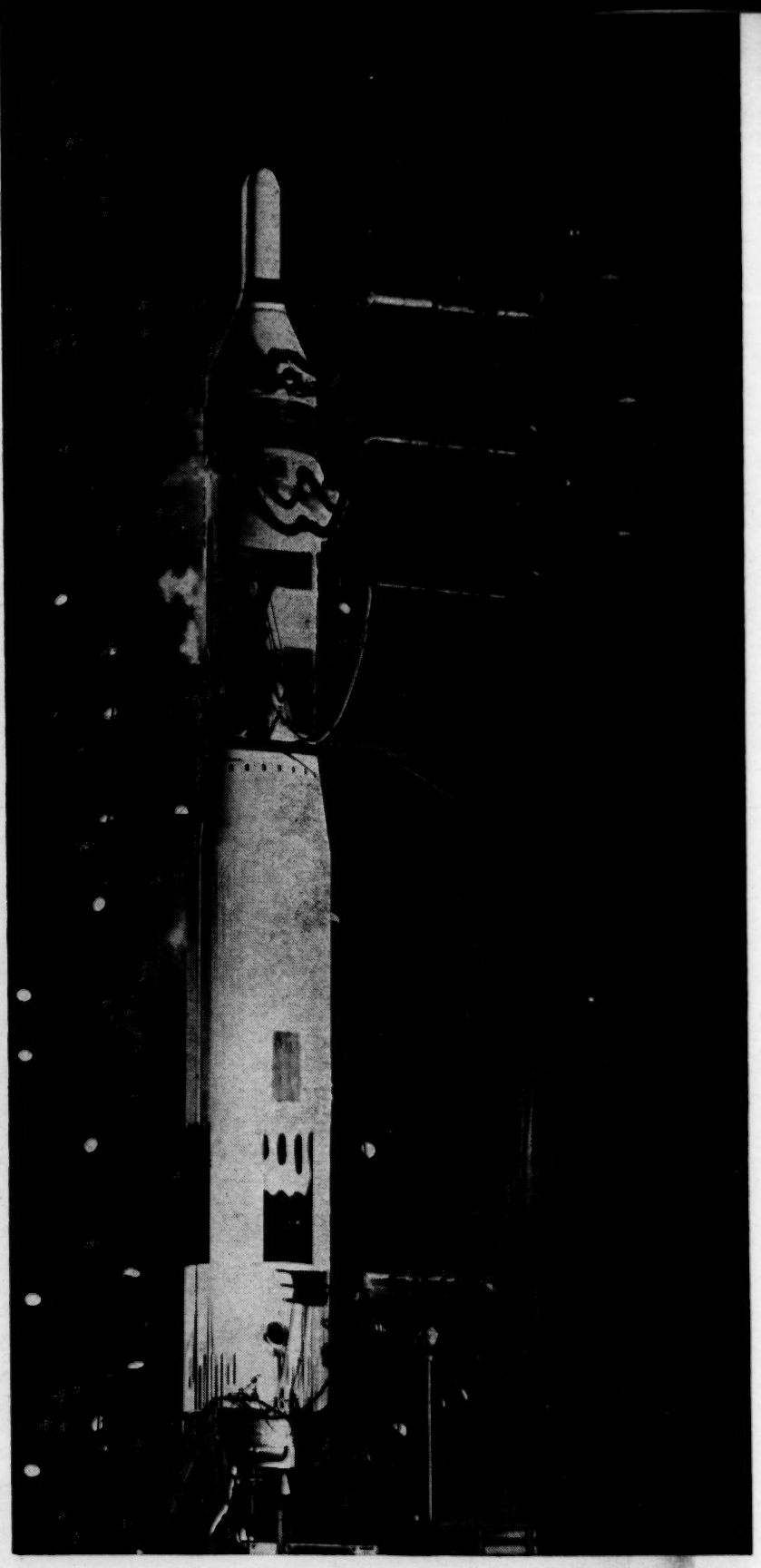
Yet to be resolved is the question whether the Air Force alone will guide the entire military space effort or whether a joint command will be formed (see p. 115). With the responsibility for developing several satellites and for developing and launching

AIR FORCE TECHNICIANS load Douglas Genie MB-1 nuclear-tipped, air-to-air, unguided missile aboard Convair F-106 Delta Dart. Standard armament for the F-106 comprises one Genie plus a number of Hughes GAR-3 Super Falcon Missiles.

REPUBLIC'S F-105 THUNDERCHIEF is a 1,400 mph. weapon system with a completely integrated fire and flight control system. Armament includes choice of nuclear or conventional bombs, guided or unguided missiles, 6,000-rounds-a-minute Vulcan 200 mm. cannon.



BOEING MINUTEMAN



MARTIN TITAN

boosters, the Air Force has the inside track for this role.

Air Force has encountered serious problems over the past year as it has attempted to get its ICBMs into initial operation. The problems arose both from construction of bases and in training USAF crews to maintain and launch the missiles.

First effort went into the liquid-fueled Atlas, whose prime contractor is the Convair Division of General Dynamics Corp. It was the first large U. S. booster capable of launching a larger warhead over intercontinental ranges and of launching a relatively heavy space payload. As a result, it has found a variety of uses in addition to its military nuclear role. With it, a variety of nose cones were tested for their re-entry qualities, and command and inertial guidance systems have been tested.

Atlas is in operational status at Vandenburg AFB, Calif. and Warren AFB, Wyo. It has been plagued with difficulties, however. Unlike the successful shots down the Atlantic Missile Range, those fired to Waopiwetok Atol over the Pacific Missile Range have been far from successful. Its contribution of initial operational Atlases to the nation's nuclear deterrent posture has been debatable.

Silo Storage

Later Atlases will be stored in silos instead of on the surface and will be raised to the surface for firing. Inertial guidance will be substituted for current radio command guidance.

The second large-payload, liquid-fueled ICBM to be developed is the Martin Titan. Unlike the Atlas, which depends on internal pressurization for structural stiffness, this two-stage missile is integrally stiffened. Titan I is designed to be stored in underground silos and hoisted to the surface for firing. Storable-fueled Titan II is designed for firing from the silo.

Both Atlas and Titan have been plagued with delays in base construction. When the programs first got underway, the construction responsibility was assigned to regional offices of the Army's Corps of Engineers. When difficulties in determining requirements were encountered and labor union jurisdictional disputes erupted, the Corps of Engineers effort was consolidated in one office in Los Angeles adjacent to the offices of USAF Ballistic Missile Division, which manages the missile programs.

Troubles continue to plague the programs, however. Production and construction work concurrent with development has resulted in a flood of

change orders which stymie final designs and delay base work.

The missile on which the Air Force pins its greatest hopes is the solid-fueled, three-stage Minuteman. By virtue of being solid-fueled, it can be stored over a long period of time and be kept at the ready with less complication. Minuteman will be fired from silos and will also be deployed on railroad cars for mobility.

One Minuteman has been fired down the Atlantic Missile Range. The Air Force is admittedly taking a gamble in committing bases to construction while the missile is only entering its test program. Plans call for 1,000 Minuteman missiles to be deployed eventually. Its load carrying ability is less than that of Atlas and Titan, but it is still in the multi-megaton nuclear yield range.

Disposition of Atlas and Titan after Minuteman becomes operational is still an unanswered question. Atlas will probably be phased out first, but Titan will stay for some time because of its greater yield warhead, which can be used for area targets.

Joint Targeting Plan

With the Navy's Polaris entering operational service last fall, former Defense Secretary Thomas S. Gates established a joint targeting group under Strategic Air Command Commander Gen. Thomas S. Power at SAC headquarters in Omaha. With SAC targeting officers wearing two hats, the Navy members felt there was an inflexible, antagonistic system in operation regarding Navy capabilities in delivering weapons.

With orders to deliver a unified targeting plan, Gen. Power sent the controversial document to the Joint Chiefs of Staff, where it encountered the objections of the Navy. The controversy was recently resolved, with the Navy satisfied with the outcome.

In the area of tactical air support for ground troops, the Army has been dissatisfied with the Air Force philosophy of placing principal dependence on nuclear weapons for use in limited conflicts. The Army is gradually entering the area of close air support with helicopters and may eventually inherit the fixed-wing role.

Policy on limited conflicts is being reviewed by the Kennedy Administration. There are indications that less dependence will be placed on nuclear weapons in limited war situations. This has raised violent objections within the Air Force. Secretary of State Dean Rusk was reported recently to be urging strengthened conventional war capability. North Atlantic Treaty Organization nations are concerned over possible diminution of U. S. support for conflicts on their soil.

A new fighter-bomber competition is being prepared by the Air Force for a follow-on to the Republic F-105 and other aircraft. The Army and Navy have been consulted for their views on requirements. Determination of requirements is due to be completed this month, and a contract is to be awarded later this year after contractor proposals have been received.

Increased Airlift

In the area of air transport, the Air Force has found immediate support in the Kennedy Administration. Accelerated and increased orders for turboprop Lockheed C-130 transports and a new order for C-135 Boeing transports have been announced. Army is solidly behind moves to strengthen both tactical and strategic airlift capabilities.

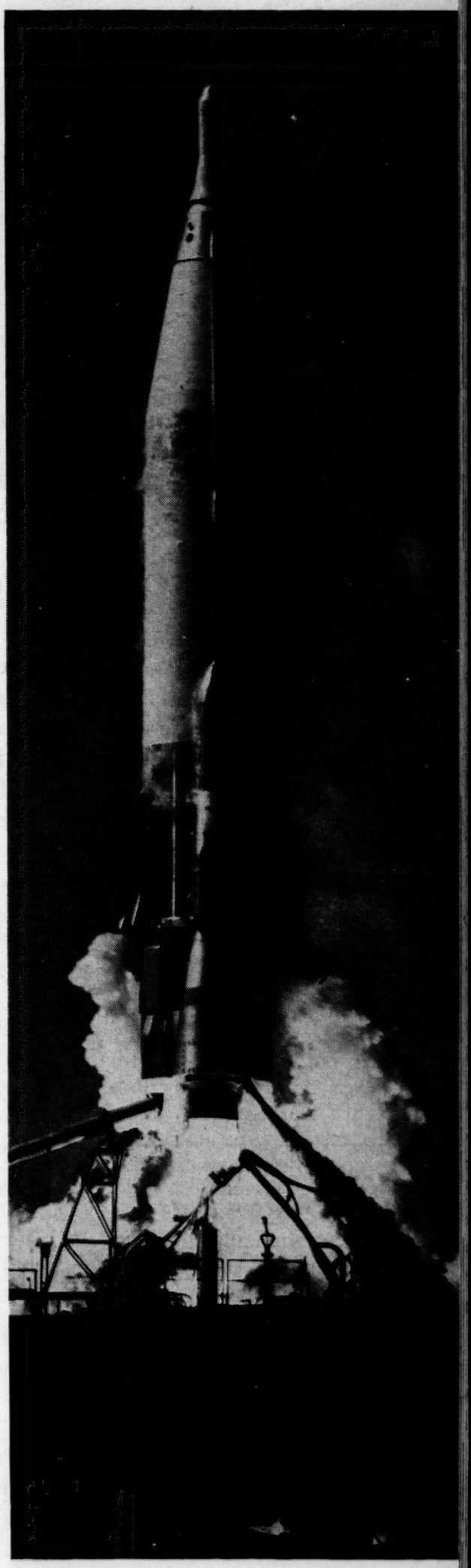
Accompanying this atmosphere of transition are personnel changes and unrest. The shifts brought by advancing technology have had a marked effect on officers who felt they had careers established as pilots and air tacticians. Yet their destiny now is tied to a gradual reduction in aircraft as missiles enter the nuclear deterrent picture.

Some have made the effort to broaden their educational base to include facets of missile and space technology, but many others are finding themselves moving out of the USAF mainstream and stagnating in pools where they perform minor, if important, administrative and support functions.

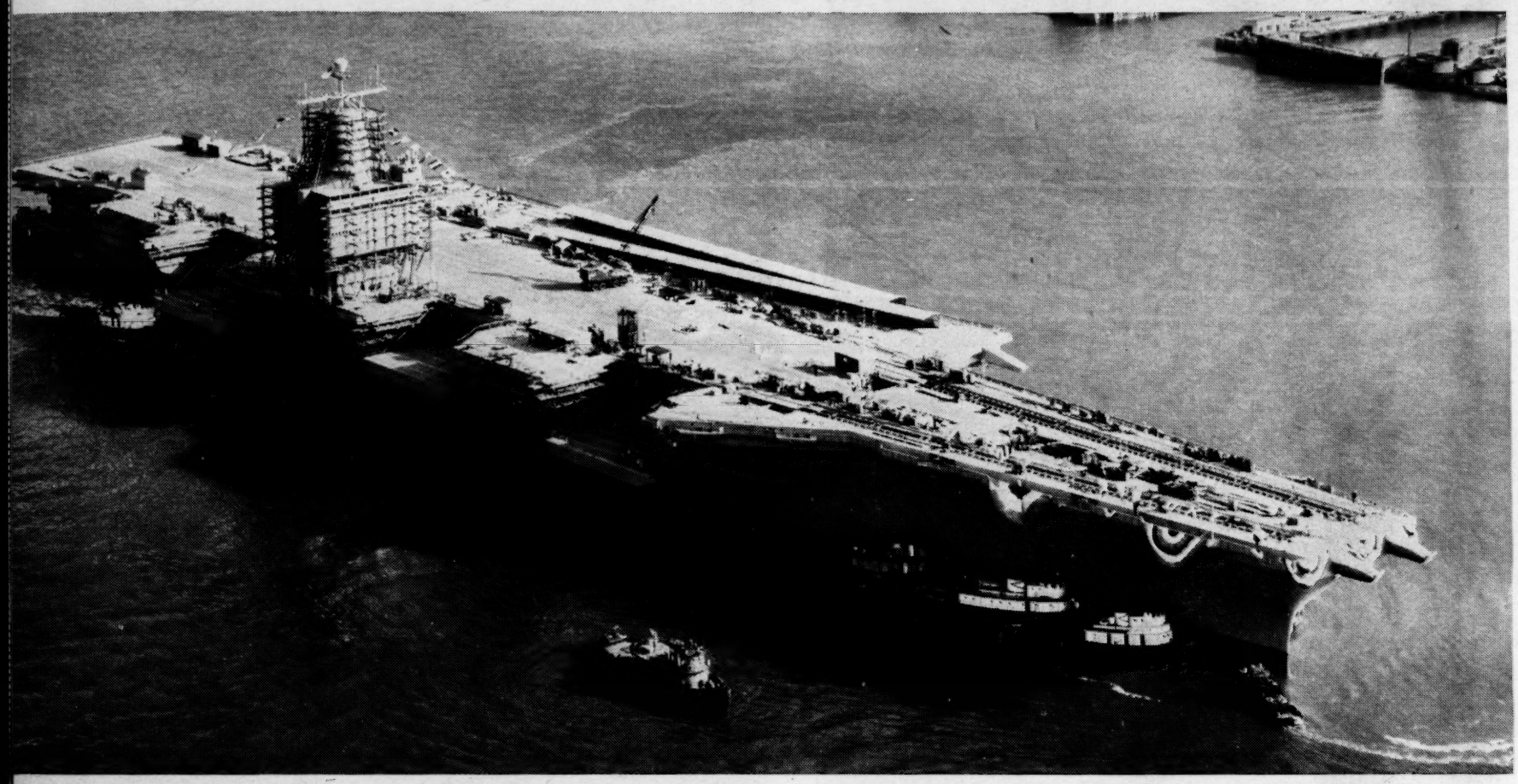
The outlook of the enlisted man is brighter. In his specialty, with additional schooling provided for him, he can shift his technical skills to meet the changes. The younger enlisted men find themselves in the position of anticipating the 20-yr. retirement of thousands of sergeants in the years from 1961 to 1965, opening advancement opportunities in all specialties.

The mid-career officer is not in so favorable a position, however. With the period of Air Force expansion and rapid promotion now largely past, the service finds itself with a larger group of colonels, many of whom have held their current rank for three quarters of their careers. They cannot be forced to retire at 20 yr. as are enlisted men.

This has led to a stagnation of promotion in the lower ranks which damages morale. Also, Congress is continuing pressure against proficiency flying pay for those rated officers who no longer have a combat flying potential. In 1960, the Air Force asked for legislation to provide for continued extra pay for officers relieved of flying status. This proposal received no support in Congress and was dropped. Another proposal, being offered this year, would provide for proportional pay based on the amount of time served as a pilot, then gradually reduced over a period of years. This will be viewed with skepticism by Congress, which seems to side with the non-flying officers of the three services, who in the missile age would serve beside rated pilots for less pay.



CONVAIR ATLAS E made a 7,000 mi. flight on Feb. 24 with a General Electric Mark 3 nose cone.



USS ENTERPRISE CVAN-65, FIRST NUCLEAR CARRIER

Navy Prunes Other Programs to Expand

Washington—Two Polaris submarines on station at the beginning of 1961, each carrying 16 fleet ballistic missiles, were symbols of the Navy's new role as part of the strategic missile deterrent force of the United States.

As a measure of the importance the Kennedy Administration places in the Polaris system, the President last month ordered accelerated placement of orders for five of the nuclear-powered submarines. A total of 19 is now either in commission or on order.

The advent of Polaris has had its effect on strategic targeting. Former President Eisenhower set up a joint targeting agency under Gen. Thomas S. Power, commander of the Strategic Air Command. An internal controversy in the agency came before the Joint Chiefs of Staff in January and was resolved there by giving Polaris greater weight in targeting. The Navy had objected that insufficient importance was given Polaris in target assignments.

Other Program Cuts

The internal adjustment of the Navy to the shift of construction funds has not been without pain. Other ship programs have had to be cut to provide the approximately $100 million required for each Polaris submarine. No other major ship procurement is scheduled for the next fiscal year, although some conversions are planned. So stringent have been the cuts in some programs that overhaul and maintenance of ships and aircraft has suffered.

Adding to the Navy's budget squeeze is the continuance of an alert ordered last summer after the U-2 incident and the breakup of the summit conference. The alert consisted of adding one attack carrier to the Sixth Fleet in the Mediterranean, and the equivalent of half a carrier to the Seventh Fleet in the Pacific.

Normal carrier deployments to these operational areas are for six months on station with two or three weeks in transit each way added to the time. With an authorized number of 14 attack carriers, the Navy was faced with adjusting its schedules for maintenance and training. Partly to offset the impact, one older attack carrier was delayed in its conversion to an anti-submarine carrier.

Financially, the Navy will probably gain relief for the increased alert by a supplemental funds request submitted to Congress in January. However, personnel problems will multiply because of the increased time career personnel will have to spend away from home.

Essentially, the increased alert is in attack aircraft, which are capable of both strategic strikes with nuclear weapons and support of ground troops in limited war actions.

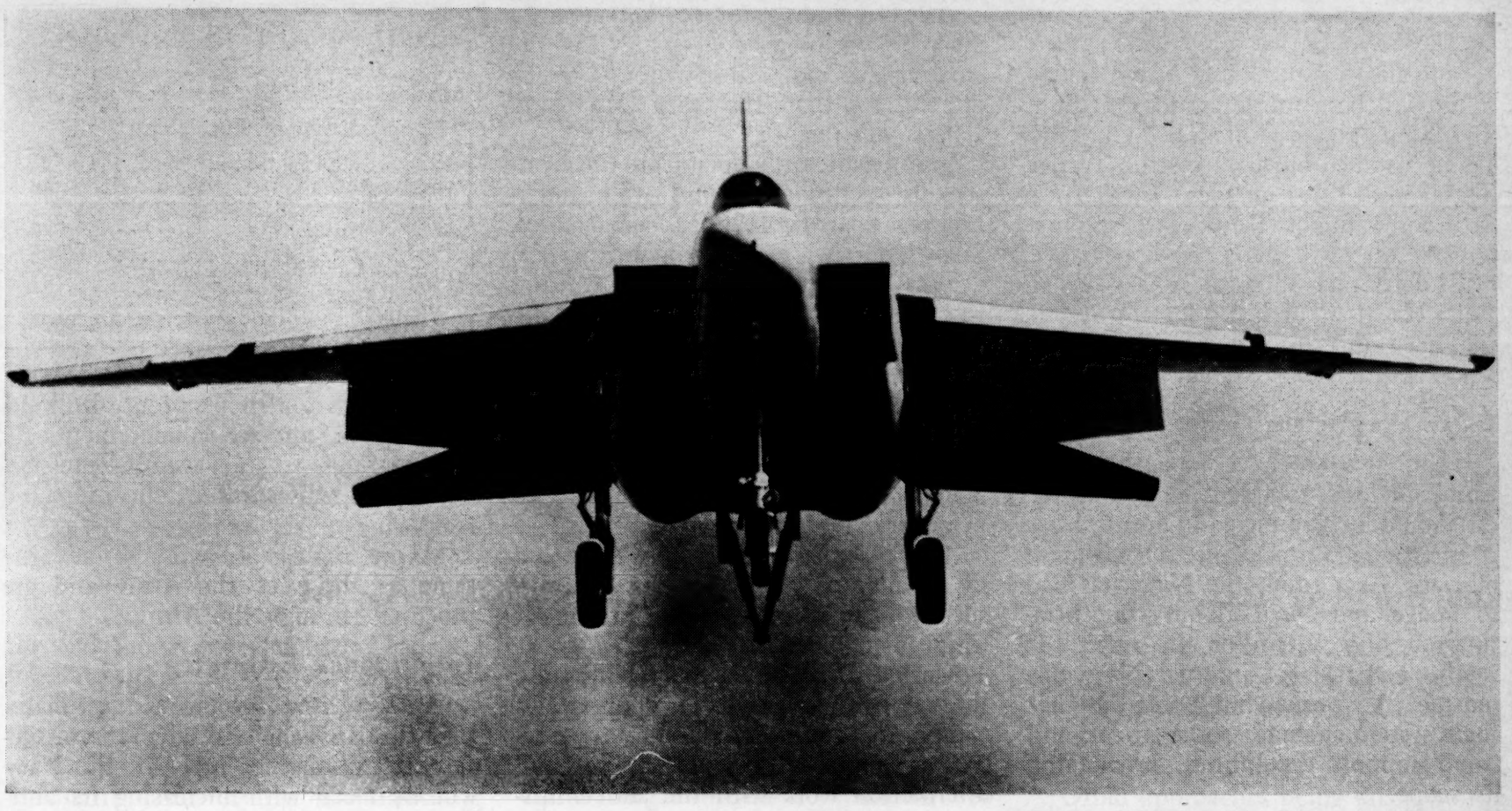
Today's mix of forces in the Navy and Marine Corps is about the same as it has been since the Korean conflict. The one outstanding change is the Polaris submarine force which is an entity of its own and has little to contribute to limited war unless its targets are those which would furnish opposition to conventional forces.

Just how long this mix will remain as it is will depend on how long ships and aircraft can be made to operate before wearing out. Replacement plans for attack carriers have run into stiff opposition in Congress. Since winning their fight for a conventionally-powered carrier for this fiscal year, Navy friends in Congress have said that a wait of at least one year will be necessary before asking for another.

Marine Alert

The Marine Corps is also affected by the alert. Since 1948 the Sixth Fleet has carried a mobile force of about 1,800 Marine troops. With the increased alert last summer, this plan was implemented for the Seventh Fleet also. This is in addition to the Marine Third Division on Okinawa.

Because of greater cost and complexity, the number of aircraft in the Navy inventory has steadily declined over the last five years of level funding. Aiding this trend also has been statutory limitation of funds for overhaul and maintenance. Many aircraft have been preserved and stored that still have a useful life of two years or more.



NORTH AMERICAN A3J-1 VIGILANTE

Polaris Force

Supply forces, overhaul activities and transportation facilities have had to shoulder a heavier load due to the increased alert.

For attack missions, the Navy is leaning heavily on aircraft now and will continue to do so in the future. The supersonic North American A3J-1 is capable of delivery of megaton weapons, but its use in small conflicts is limited.

As a result, the procurement of this type of aircraft for carrier use has been the subject of internal Navy controversy. Opponents maintain that the Navy should not invade the mission area of the Strategic Air Command, but should limit its capabilities to aircraft capable of both conventional and nuclear weapon delivery, designed mainly for use in small war situations.

Shift to Jets

For close support and interdiction missions when troops are engaged ashore, the Navy is rapidly shifting from the old propeller-driven Douglas AD series to the A4D series. A substantial portion of this single place, single turbojet engine aircraft purchase will be the A4D-2N all-weather attack version. Follow on to the A4D is the Grumman A2F twin turbojet plane, capable of low altitude penetration.

For air defense and close support work, the Navy is leaning heavily on the McDonnell F4H all-weather twin-jet Mach 2.35 aircraft. Continued purchases of the A4D, A2F and F4H will make these three aircraft the eventual backbone of the carrier attack aircraft mix. Another aircraft which is still being produced is the Chance Vought F8U-2N, also an all-weather fighter. Its top speed is just under Mach 2.

Aiding in the aerial defense of the fleet is the currently produced Grumman WF-2 twin-engine early-warning plane which will be succeeded by the twin turboprop powered W2F which will go into production next year.

Fleet air defense systems under development are the Eagle-Missileer and Typhon systems. The Missileer aircraft would be subsonic, heavy load carrying type, capable of loitering about 200 mi. from the fleet. The Eagle missiles would have an air-to-air intercept and kill range of 200 mi.

Currently the Eagle development is funded for both fiscal years 1961 and 1962, but the Missileer 1961 funds

Navy Aircraft on Order Fiscal 1961

AIRCRAFT TYPE	POPULAR NAME	MANUFACTURER
F8U-2N	Crusader	Chance Vought
F4H-1	Phantom II	McDonnell
A2F-1	Intruder	Grumman
A4D-2N	Skyhawk	Douglas
A4D-5	Skyhawk	Douglas
A3J-1	Vigilante	North American
S2F-3	Tracker	Grumman
W2F-1	Hawkeye	Grumman
P3V-1	Trident	Lockheed
GV-1	Hercules	Lockheed

Navy Missiles on Order Fiscal 1961

MISSILE	MISSION	MANUFACTURER
Polaris	Subsurface-to-Surface, ballistic	Lockheed
Sparrow III	Air-to-Air	Raytheon
Sidewinder	Air-to-Air	Philco
Bullpup	Air-to-Ground	Martin*
Terrier	Surface-to-Air	Convair
Talos	Surface-to-Air	Bendix
Tartar	Surface-to-Air	Convair-Allied Physics Laboratory
Hawk	Surface-to-Air	Raytheon#

*Second source being chosen
#Purchased through Army

have been stretched over two years.

The Typhon system involves surface-to-air missiles fired from ships. They will be a mix of short-, medium- and long-range missiles. Currently being installed on ships are the Terrier, Tartar and Talos missiles. In the near future the Super Talos, with a range of 200 mi., will make its appearance.

Closely tied into these systems is the Naval Tactical Data System (NTDS) and its air counterpart the Air Tactical Data System (ATDS).

DOD Skepticism

That two such complex systems which include complete computer tie-ins should be committed to fleet defense is questioned by Defense Department officials. As a result the Navy has had to hedge and avoid all-out concentration on one system or the other. It is also a matter of internal Navy dissension. Air proponents point out that their system includes shore attack and troop support capabilities, broadening its scope.

Proponents of placing missiles aboard destroyers and cruisers have gone a step further in having plans for the nuclear-powered cruiser Long Beach altered so that the ship can carry Polaris missiles.

Fighter aircraft depend on the heat-seeking Sidewinder and the radar-homing Sparrow III air-to-air missiles. Sidewinder, which is being further developed with radar all-weather features, is in production in Germany for use with NATO forces. For close support work the Bullpup air-to-surface missile is in quantity production for both the Navy and the Air Force. A second source for production of the missile is being sought with a decision due to be made next month.

All carrier combat aircraft can readily be adapted to fire rockets and missiles and carry high explosive or nuclear warhead weapons.

Marine Corps aircraft capabilities are the same as the Navy's. Pilot tactics training is about the same but puts greater emphasis on close support and interdiction work with the added mission of surveillance from small fixed-wing aircraft and helicopters. Only departures in aircraft procurement for the Marines are in assault transport helicopters, observation helicopters and fixed-wing tanker aircraft.

Marine battlefield missiles are the same as those of the Army and are procured through the Army.

Navy Active Aircraft Inventory

(End of Fiscal Year)

1958	10,533
1959	9,649
1960	8,863
1961	8,768*
1962	8,401*

*Planned

Intelligence Estimates

With revised intelligence estimates that the Russians will have 18 missile-carrying submarines in 1965, the Navy will be faced with increasing its anti-submarine effort.

In air ASW, there will be continued procurement of the Grumman S2F-3 twin-engine carrier hunter-killer aircraft, the Sikorsky HSS-1N all-weather helicopter, and, for the first time, the HSS-2, twin-turbine helicopter. For land based operations the Lockheed P3V, an ASW version of the Electra, turboprop commercial airliner, will enter the fleet next year. Production of the piston engine P2V will continue.

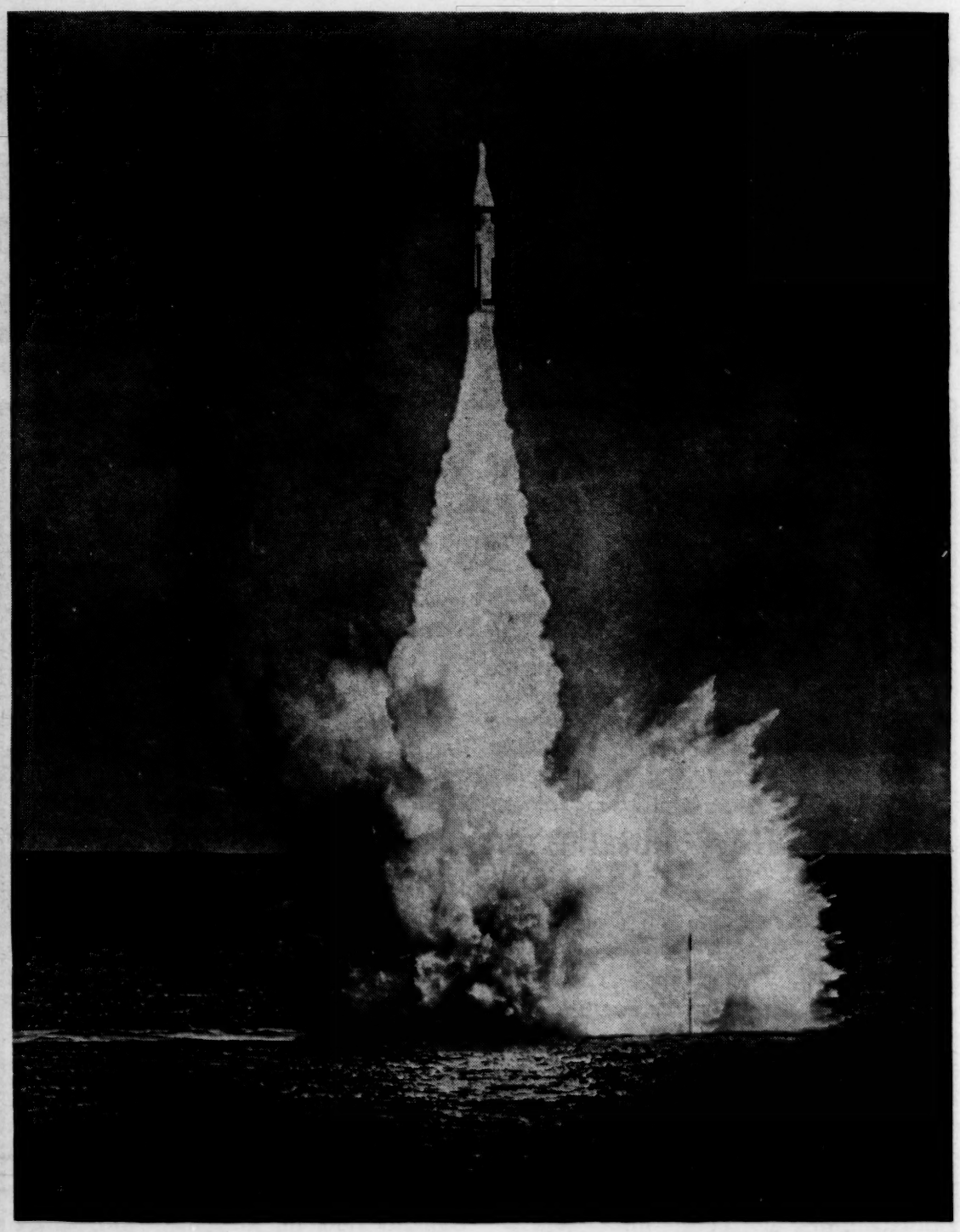
Proposals have been made to the Navy to develop smaller twin-turboprop aircraft for the land-based ASW role. No decision has been reached.

Anti-submarine warfare ties together many diverse elements of the Navy. Fixed bottom post listening and other long-distance sound detection systems will be used to notify ships and aircraft of general areas to search. ASW submarines will help guard fleet units. But for final pinpointing, the dipping sonar carried by helicopters and sonobuoys dropped by patrol aircraft, both land-based and carrier-based, are used.

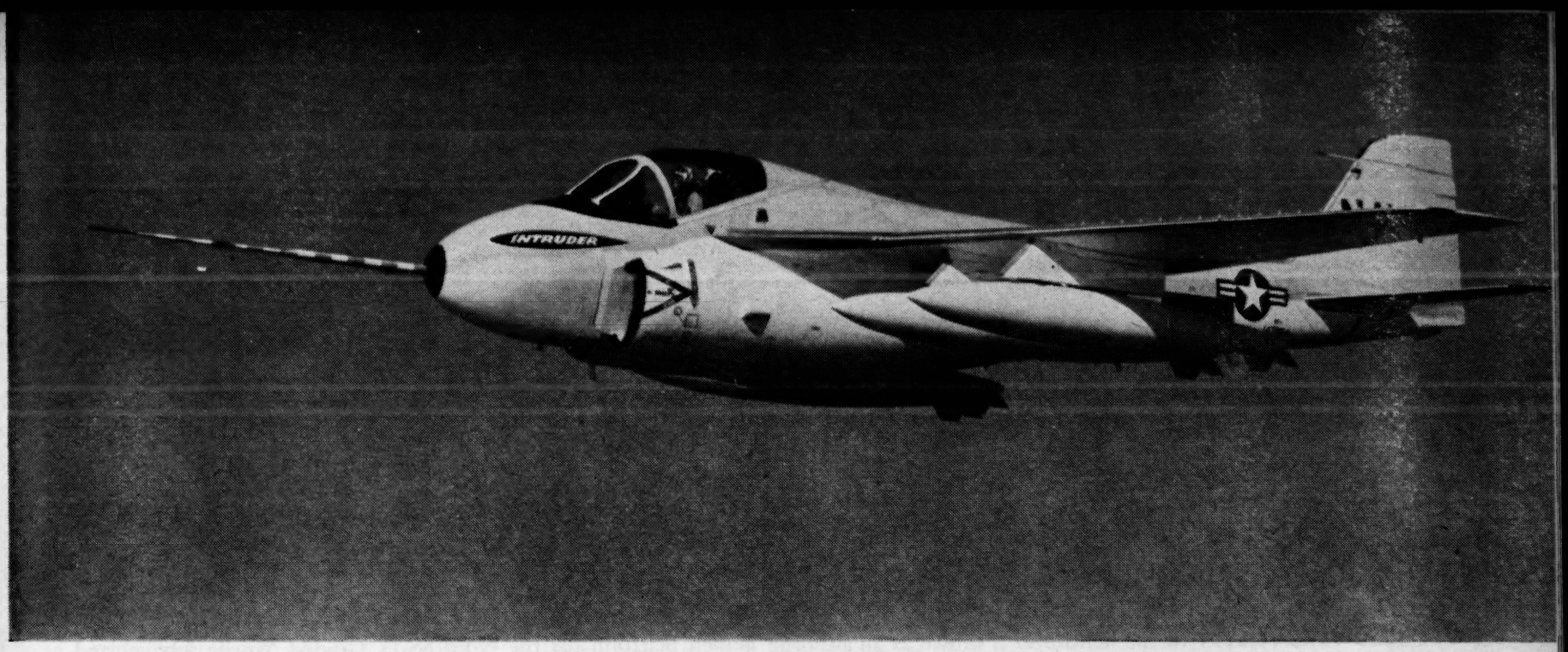
Available Weapons

Once contact has been established with a submarine there are several sophisticated weapons available now that were not yet developed in World War II. The homing torpedo has been refined to a point where it is the standard attack weapons for both ships and aircraft. These torpedos, or underwater missiles, home acoustically and destroy the submarine with high explosive warheads.

The most potent weapon against submarines now in the Navy's inventory was announced last year. It is Lulu, a nuclear weapon which extends



POLARIS A1 SUBMARINE LAUNCH



GRUMMAN A2F-1 INTRUDER

the kill range considerably. Designed for launching from helicopters and fixed-wing aircraft, the weapon reduces the accuracy needed in locating a submarine. Lulu presents a problem in making it mandatory that the launching aircraft clear the immediate area before it is triggered because the explosion would endanger the aircraft. Delay mechanisms have been developed to offset this danger.

Additional Approach

Another approach to delivering Lulu is the utilization of an unmanned helicopter. The Drone Anti-submarine Helicopter (DASH) is designed to be operated from platforms on small ships of the destroyer and destroyer escort classes. In pressing an attack with DASH there need be no concern about damage or destruction of the aircraft, so no delay mechanisms are necessary for the weapon.

For evaluation purposes the Navy is purchasing 10 DSN-3 drone helicopters from the Gyrodyne Co. Nonpilot officers aboard destroyers have already learned to operate the aircraft.

In operating manned helicopters carrying dipping sonar rigs, the Navy has had to overcome difficulties presented by having to hover over the water at altitudes of 25-50 ft. Daytime hovering can be accomplished by visual methods. Nevertheless, the maneuver requires full-time attention of one pilot with both hands occupied. Doing the job manually at night, without special equipment, is not possible.

Sikorsky Aircraft developed automatic hover systems originally in the HSS-1N. In the larger, twin-turbine powered HSS-2, automatic stabilization equipment and automatic hover equipment will be standard items. Pilots will have to monitor the operation only, and will be able to concentrate on the interception and kill operation.

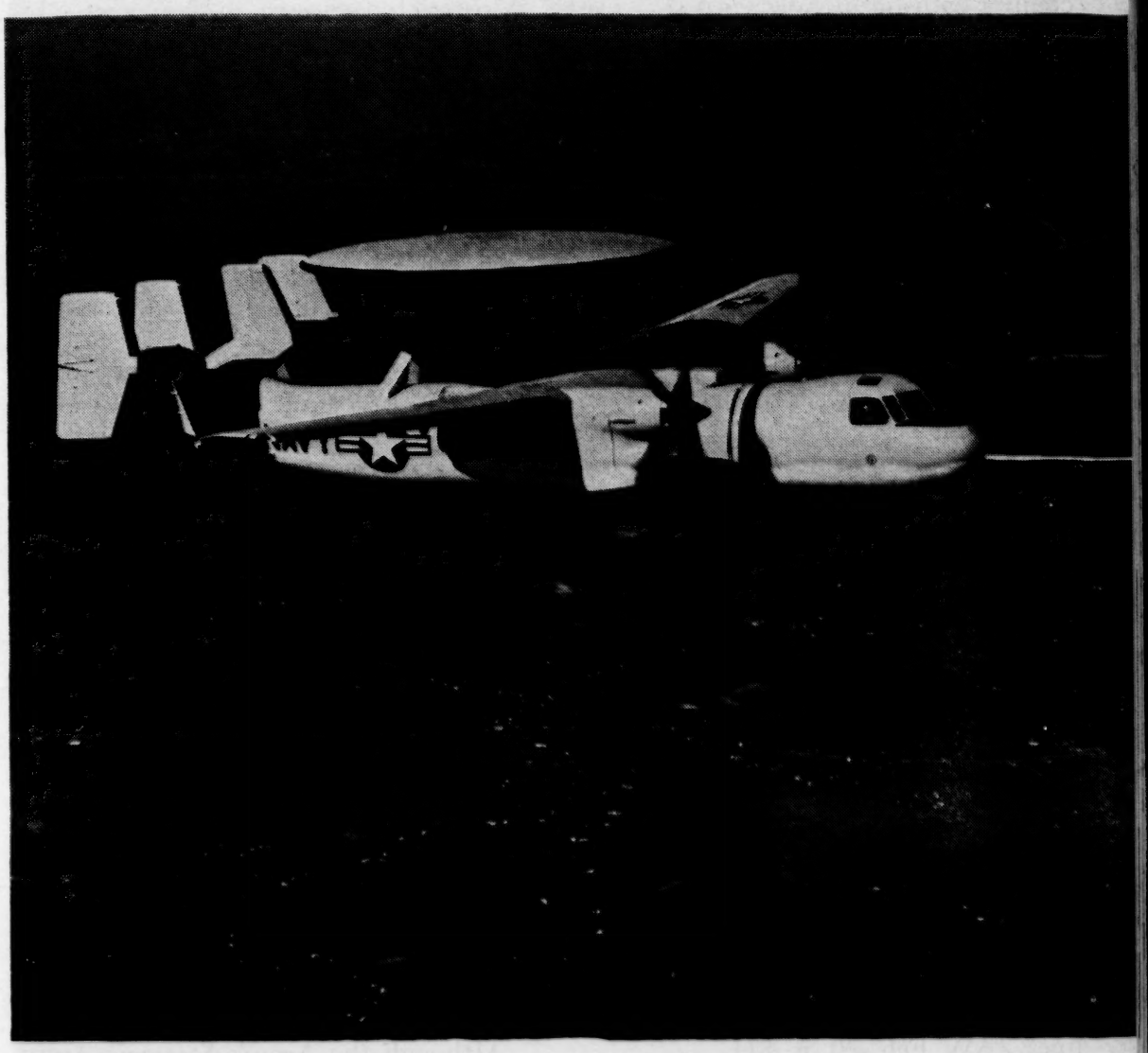
With the A1 version of the Polaris ballistic missile now operational, development work on the A2, 1,500-mi. version is well under way. A further approach is being pushed in the A3, 2,300-mi. version. Improvements in solid propulsion mixes coupled with lighter weight missile components will make the improvements possible.

The Navy's space program is a modest one, and even that is under attack as a diversion of effort for defense purposes. The greatest Navy contribution is the Pacific Missile Range, which it operates for the use of all government agencies. About $90 million per year goes into its operation.

The Transit navigation satellite is the Navy's only active space program. By 1962 it is planned to have the system operational. Ships at sea will be able to determine their positions down to one tenth of a mile.

Other approaches being taken by the Navy in regard to space include a single pass reconnaissance satellite which could complete its mission before being tracked and destroyed, and a vertical probe type of anti-satellite weapon which would not have to track a satellite in order to intercept it.

The weapon would explode in a satellite's path and would leave a cloud of buckshot for the satellite to run into.



GRUMMAN W2F-1 HAWKEYE

BATTLEFIELD VERSATILITY of the helicopter is shown as an airborne launch platform for the Nord SS-11 Guided Missile (above) and as an aerial ambulance (shown opposite page). Reconnaissance helicopters can test the enemy's potential and strength by actual fire with . . .

Army Renews Drive for Zeus Anti-ICBM

Washington—Renewed controversy over the Nike Zeus anti-missile missile, for which top Army officials have been urging commitment to production of long lead time components, ushered the Army into 1961.

Opposition, principally from within the research and engineering organization of the Department of Defense, has insisted that the worth of Zeus be proved before any production decision is made. The reasoning of this group is that no start should be made on a multi-billion dollar program until there is no doubt remaining as to technical feasibility and necessity.

The Army, on the other hand, says that breakthroughs have been made in detection and ability to intercept incoming ballistic missiles, and that even discrimination against decoys is possible. Nike Zeus testing against Atlas ICBMs will get under way in the Pacific Missile Range late this year.

USAF Concept

Nike Zeus is the only anti-ICBM system close to becoming operational, the Army claims. Air Force studies are for a system which would perform the interception in the powered phase after a missile rises above the cloud layer. This would be accomplished by a satellite interceptor. Army officials say they have no quarrel with such a system, but they say that it is years away. Nike Zeus, they contend, could become operational in a relatively short time.

Basically, the controversey centers around which service will be the recipient of a large segment of the funds set aside for missile defense in the next five years.

Fiscal year 1961 saw significant strides made in Army aviation. A decision of the Secretary of Defense permitted the Army for the first time to procure major aviation items instead of having to depend on the Air Force and Navy. The Army wants to develop its own in-house capability along these lines. (AW Feb. 20, p. 81).

A limitation of 5,000 lb., imposed on Army aircraft in 1957, has been a source of irritation, principally because Army aviators feel that no other service is interested enough in the short takeoff and landing (STOL) type of aircraft to aggressively develop larger cargo and assault transport types.

In the vertical takeoff (VTOL) field, the Army is actively supporting the triservice VTOL project (AW Feb. 27, p. 33). It is also investigating other approaches to the problem of operating from unprepared fields under adverse conditions.

The most significant change which will take place in the Army aviation inventory will be the aircraft used for observation missions. To date, and for about two years to come, the missions have been performed by small fixed-wing aircraft. These are to be phased out as helicopters are procured in increasing numbers.

A competition for a light observation helicopter is currently in progress. It is planned to buy 3,500 of these aircraft to perform the observation mission.

For surveillance, the Army obtained an exception to the weight limitation. The result is the Grumman AO-1 Mohawk, a twin-turboprop aircraft which will carry side looking radar for battleground information gathering purposes.

Although the Army's Strategic Army Corps concept is not new, indications are that it will gain impetus from the Kennedy Administration. One order the President has already given has increased USAF's strategic troop airlift capability by 53 aircraft, 30 of them jet aircraft and 23 of them turboprop (AW Feb. 13, p. 30).

Another exception to the 5,000-lb. weight rule is the de Havilland AC-1 assault transport. In the STOL category, the aircraft is designed to carry 20-25 combat equipped troops into and out of small, rough fields (AW Jan. 23, p. 56). A total of 51 of these aircraft are either on order or have been purchased.

Army aviation differs from the aviation of the Air Force and the Navy in that it is an integral part of the Army's combat team. Army pilots are combat officers first and pilots second. This does not mean that they are not proficient in the techniques of piloting, but their outlook and skills combine to make them part of a mobile team.

Extensive Studies

Air mobility, in practice, is still in its infancy. Many different avenues of transporting the individual fighting man or teams of men are being investigated. The Army has sponsored more studies on one-man helicopters

Army Active Aircraft Inventory

(End of Fiscal Year)

1958	5,027
1959	5,199
1960	5,493
1961	5,657*
1962	5,736*

*Planned

. . . guns, rockets and missiles, hovering at or below tree-top level. Helicopter in photos is the Bell HU-1A turbine-powered Iroquois, with the de Havilland AC-1 Caribou shown in background of above photo.

Production

than any other service. It has also investigated more approaches to VTOL than any other service.

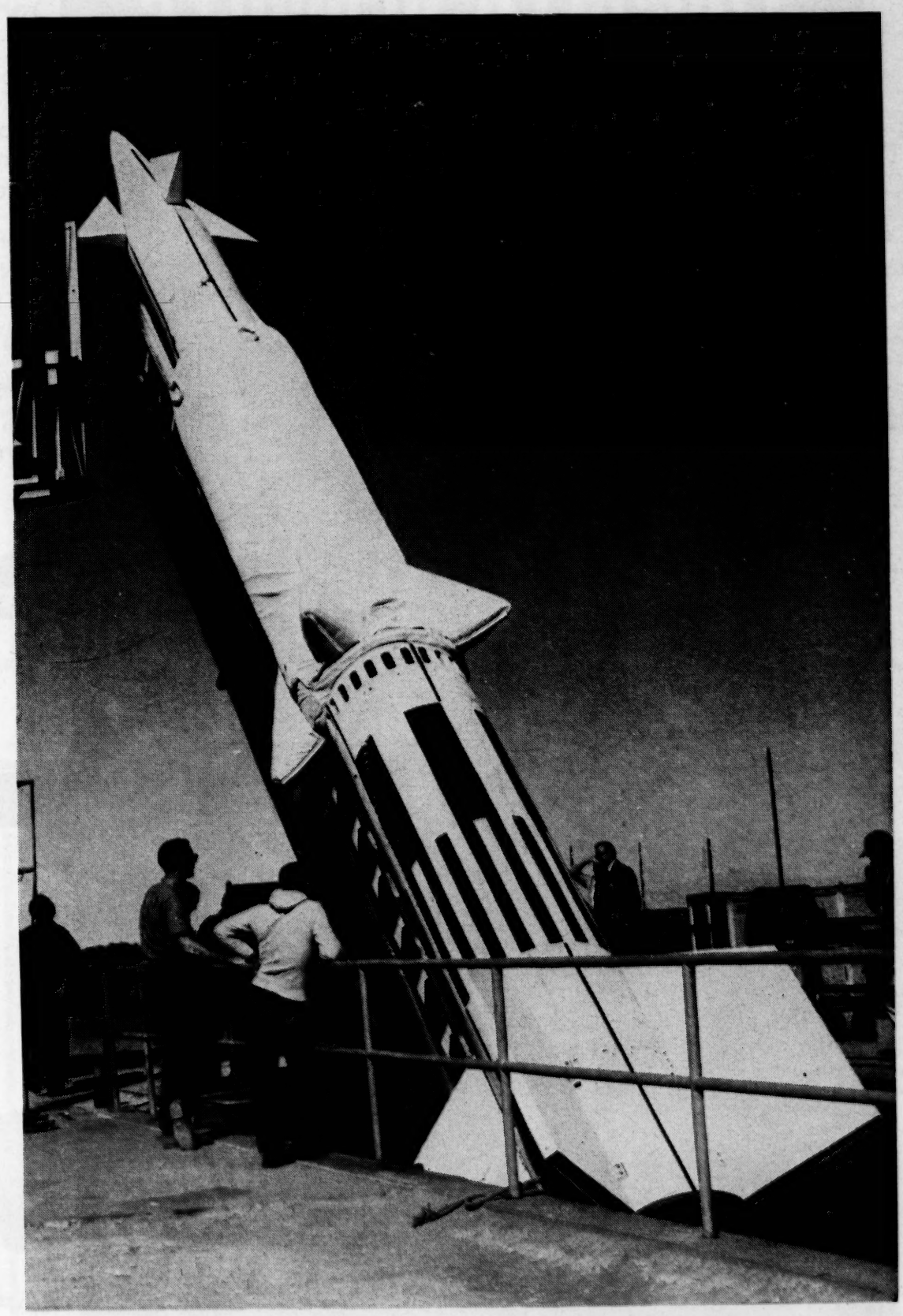
Ground transportation will remain a basic part of the Army for some time to come. By 1965 it is the hope of planners to have a large enough strategic airlift available to carry large numbers of troops and equipment anywhere in the world in a short period of time. When the troops are in the theater of action, the preferred method of transporting troops will be by helicopter or STOL aircraft. This is the Army version of the Marine "vertical envelopment" concept.

Combat Function

On the battlefield, reconnaissance helicopters will test enemy potential and strength by actual fire with guns, rockets and missiles. As contracted to close support aircraft, these helicopters will fly "in the nap of the earth," at or below tree-top level, shooting from hovering positions close to cover. Thus aerial combat reconnaissance will combine all the functions of a conventional cavalry with an air-to-ground and a ground-to-ground fighting capability.

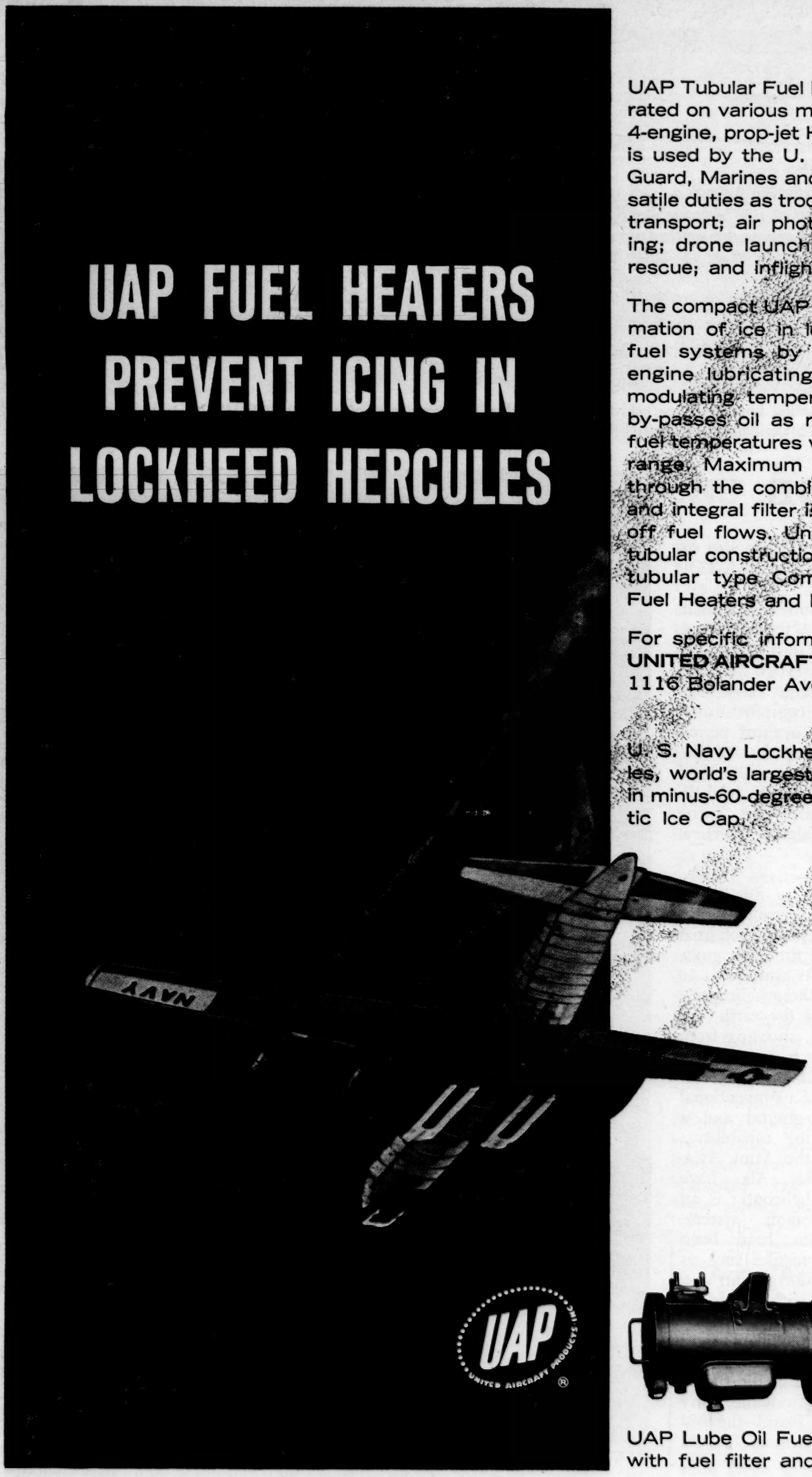
Tests performed at the Army Aviation Board, Ft. Rucker, Ala., have shown that an armed helicopter is an efficient combat weapon system. Numerous combinations have been tried, including firing missiles such as the Nord SS-11 from the ground and in the air to targets within line of sight and even over hills. Eventually it is intended to design a helicopter and its weapons as one system.

What can be expected in the future in Army Aviation stems from the Army Requirements Review Board—the so-called Rogers Board—named for its chairman Lt. Gen. Gordon B. Rogers,



NIKE ZEUS ON R&D LAUNCHER

UAP FUEL HEATERS PREVENT ICING IN LOCKHEED HERCULES

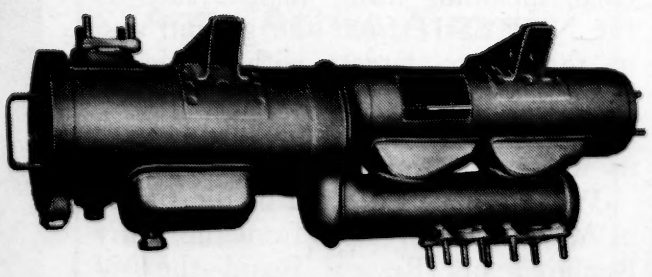


UAP Tubular Fuel Heaters are incorporated on various models of Lockheed's 4-engine, prop-jet Hercules. The C-130 is used by the U. S. Air Force, Coast Guard, Marines and Navy for such versatile duties as troop, cargo and missile transport; air photography and charting; drone launching; air search and rescue; and inflight refueling.

The compact UAP heaters prevent formation of ice in low pressure engine fuel systems by utilizing heat from engine lubricating oil. An automatic modulating temperature control valve by-passes oil as required to maintain fuel temperatures within a 40°—70° F. range. Maximum fuel pressure drop through the combination heater, valve and integral filter is only 1 psi at take-off fuel flows. Unit is stainless steel, tubular construction. UAP also makes tubular type Compressor Bleed Air Fuel Heaters and Fuel Oil Coolers.

For specific information, call or write **UNITED AIRCRAFT PRODUCTS, INC.**, 1116 Bolander Avenue, Dayton, Ohio.

U. S. Navy Lockheed C-130BL Hercules, world's largest ski plane, operates in minus-60-degree weather on Antarctic Ice Cap.



UAP Lube Oil Fuel Heater U-524240, with fuel filter and control valve.

Circle Number 84 on Reader-Service Card

which completed its studies last year.

Objectives the Army hopes to fulfill:

- **Each division** to have the capability of moving at least a company of infantry by its organic airlift.
- **Each division** and each cavalry squadron to have an organic aerial reconnaissance troop.
- **Aerial surveillance** to match firepower at each echelon.
- **Rapid reduction** of variety of aircraft types to simplify spare parts inventories.
- **Purchase of flying cranes,** such as the Sikorsky S-64, a twin-turbine powered helicopter.
- **Increased logistic capabilities.** These can be met with the AC-1 Caribou and the YHC-1B Chinook, a twin turbine tandem rotor helicopter built by Vertol.

Army Aviation

Army aviation got its start in 1942 when authority was granted for the ground divisions to operate organic aircraft. Few pilots elected to remain in the Army when the Army Air Forces was formed and later when the Air Force was formed as a separate service. As a result, few senior officers of the Army are pilots.

Greatest growth for Army Aviation has come since 1954. On June 30, 1960, the aircraft inventory was 5,493. Estimates for June 30, 1961, and June 30, 1962, are 5,657 and 5,736, respectively. This growth in the number of aircraft is in contrast to the Air Force and the Navy whose inventories have been steadily declining.

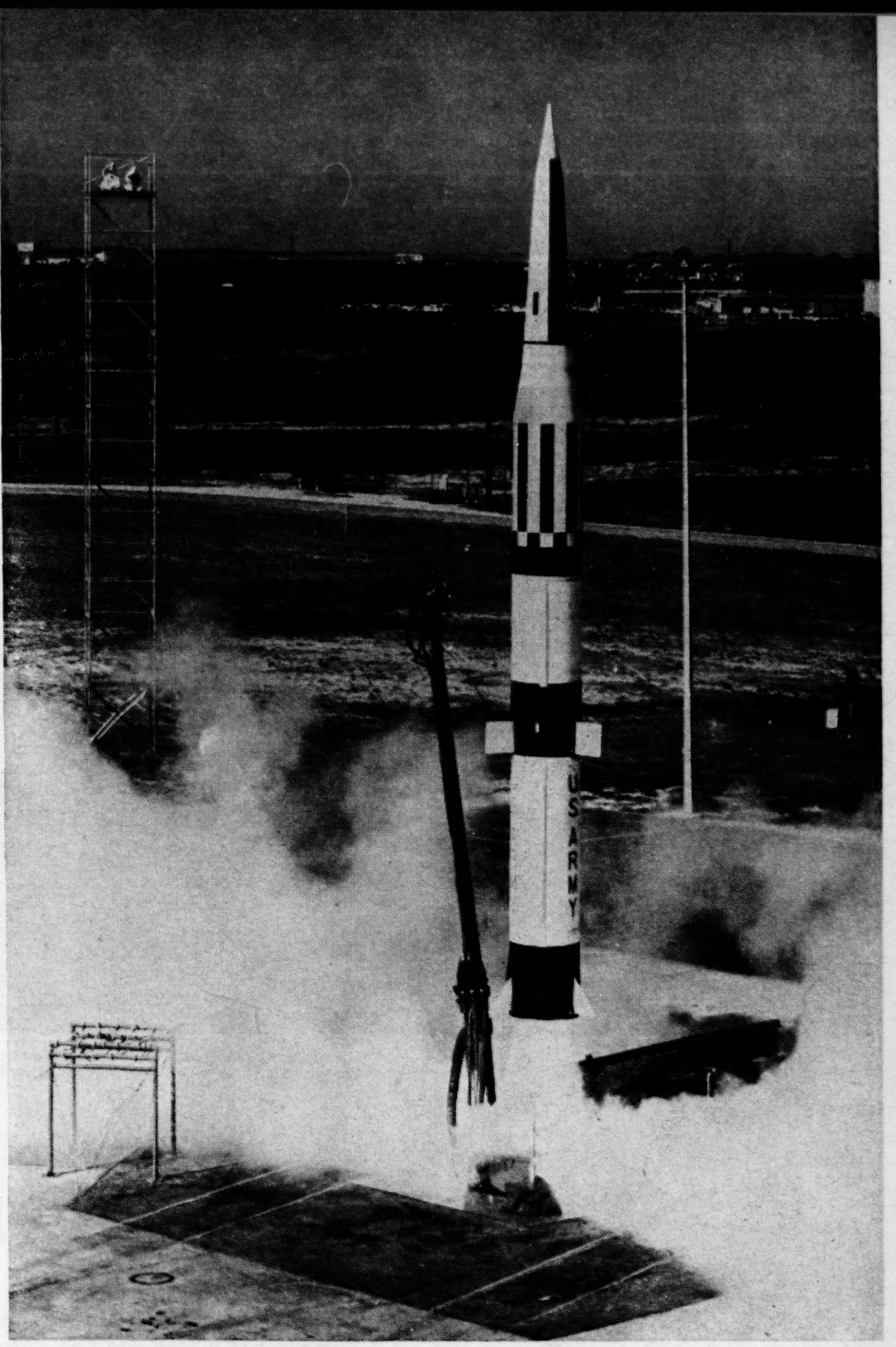
In rotary-wing aircraft, the Army has become the largest operator, with a total almost equal to all other U. S. military and commercial operators put together. The helicopter inventory on June 30, 1960, was 2,633. On June 30, 1961, estimated number will be 2,774 and on June 30, 1962, 2,841.

Three separate missions are prescribed for Army aircraft. First is the observation mission, second the surveillance mission, and third the transport mission.

Things to Come

The shape of things to come can be predicted, using current state of the art as a guideline. However, for the 1960-1970 decade a profound change could be wrought if a breakthrough in V/STOL vehicles occurred. For instance, the ground effects machine (GEM) could well prove to be efficient vehicle for Army needs.

There could also be some radical new propulsion system developed which, combined with new materials for weight reduction, would produce a machine capable of maneuvering easily and rapidly in the tree top regions. However, the Army does not



U.S. ARMY PERSHING

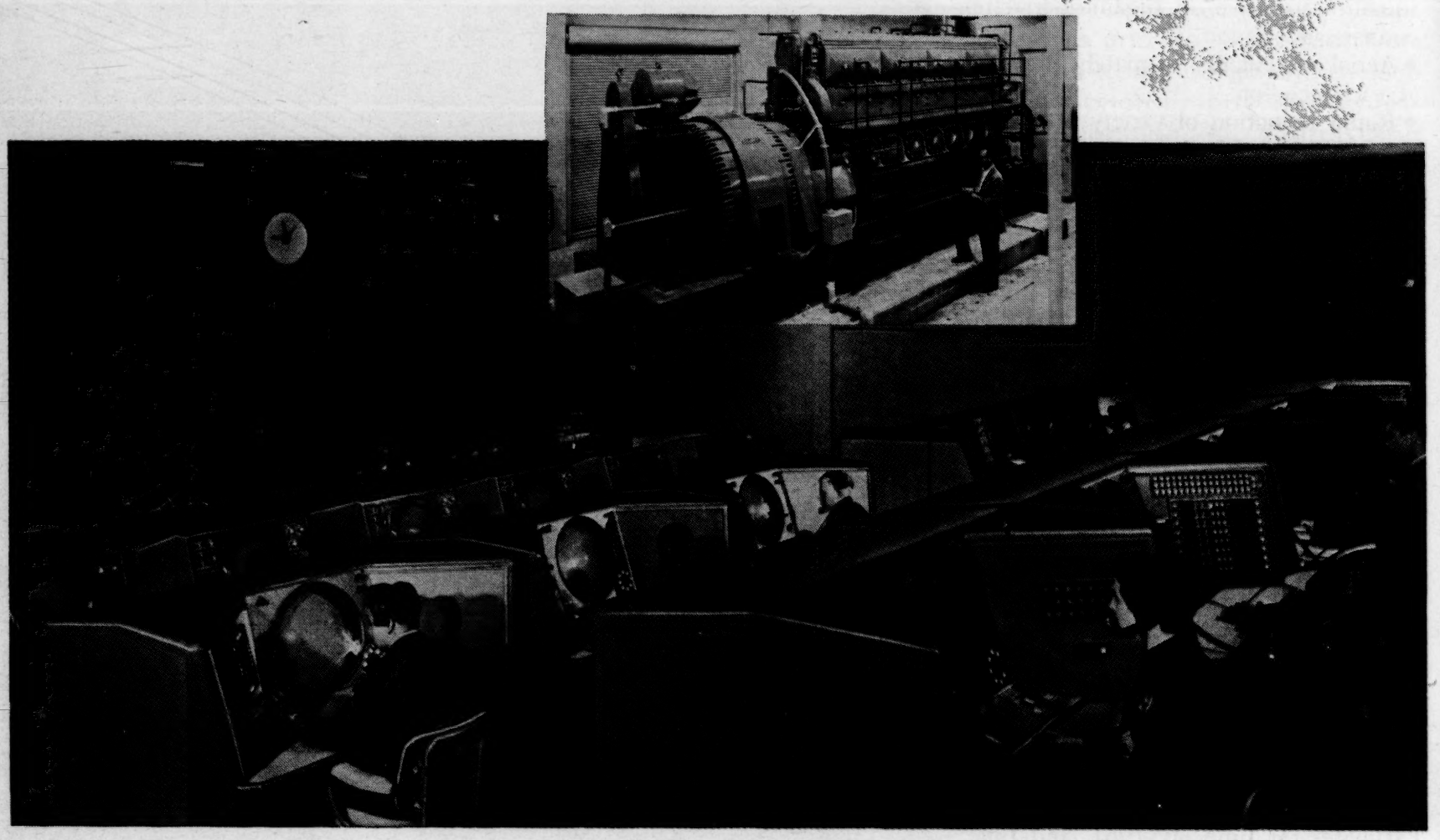
Army Aircraft on Order Fiscal 1961

AIRCRAFT TYPE	POPULAR NAME	MANUFACTURER
AO-1 Observation	Mohawk	Grumman
AC-1 Assault Transport	Caribou	DeHavilland
HU-1 Utility Helicopter	Iroquois	Bell
HC-1 Transport Helicopter	Chinook	Vertol

Army Missiles on Order 1962

MISSILE	MISSION	MANUFACTURER
Sergeant	Surface-to-Surface	Sperry
Honest John	Surface-to-Surface	Emerson Electric-Douglas
Little John	Surface-to-Surface	Emerson Electric
Lacrosse	Surface-to-Surface	Martin
Hawk	Surface-to-Air	Raytheon
Davy Crockett	Surface-to-Surface	
Nike Hercules	Surface-to-Air	Douglas
SS-10	Air-to-Surface	Nord
Redeye	Surface-to-Air	Convair
Pershing	Surface-to-Surface	Martin

WHITE SUPERIOR ENGINES



Operations Room—heart of *Missile Master*. System was designed and produced by Orlando Division of The Martin Company, in cooperation with U. S. Army Signal Corps.

...on guard with MISSILE MASTER

At U.S. Army *Missile Master* anti-aircraft installations near Pittsburgh, Chicago and Los Angeles, standby power is supplied by 8-cylinder, supercharged Model 65 White Superior engines. The 12 engines (4 at each site) develop 1415 BHP at 600 RPM to drive 1000 KW generators. The engine-generators produce precise frequency to operate radars, communication and data transmission links, visual display consoles, computers and fire integration facilities. *Missile Master's* electronic system provides semi-automatic coordination and fire direction for Nike missile batteries, and has been installed near vital U.S. metropolitan and industrial centers.

Missile Master joins a growing, impressive list of Superior-powered U.S. defense assignments that are convincing evidence Superior engines provide rugged dependability, trouble-free performance and economical fuel consumption. Superior engines —215 to 2150 HP or 150 to 1500 KW—will also meet your exact power requirements. Write today for complete information.

Superior ENGINES | White DIESEL

White Diesel

WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY
Plant and General Offices: Springfield, Ohio

want highly sophisticated and consequently expensive systems. What it needs is a large quantity of currently available vehicles which can be produced inexpensively.

In the missile field, the Army has separately organized surface-to-surface missile battalions. The Martin Pershing is a solid propellant tactical missile which reaches out far enough to perform interdiction missions and hit rear areas.

Sperry's Sergeant performs a similar mission but Sergeant has a shorter range.

Substantial procurement will continue for these two missiles and the number of units operating them will increase next fiscal year.

Air Defense

In the area of air defense the next fiscal year will see the last anti-aircraft gun battalion disappear. A complete switch to surface-to-air missiles will have been made.

Nike Ajax battalions, now in commission, will begin to switch to the longer range Nike Hercules which is also capable of carrying a nuclear-warhead. Nike Ajax equipment will be transferred to the National Guard. For low level anti-aircraft defense the Hawk missile will be procured in increasing numbers.

The most radical departure in tactical missiles will come in Davy Crockett, a battlefield weapon with nuclear capability. This missile, about 5-ft. long and with a bulbous warhead nose which is of larger diameter than the rocket case, can be fired **2.5 mi.** It can carry a conventional high explosive as well as a nuclear warhead. Yield of the latter can be as high as 20 kilotons.

Maintenance and overhaul of Army aircraft will continue to be a mix of in-house capability and contractor furnished services.

The in-house capability is composed mainly of troops whose training must continue in order to support deployed forces. They form approximately 40% of the maintenance and overhaul capability.

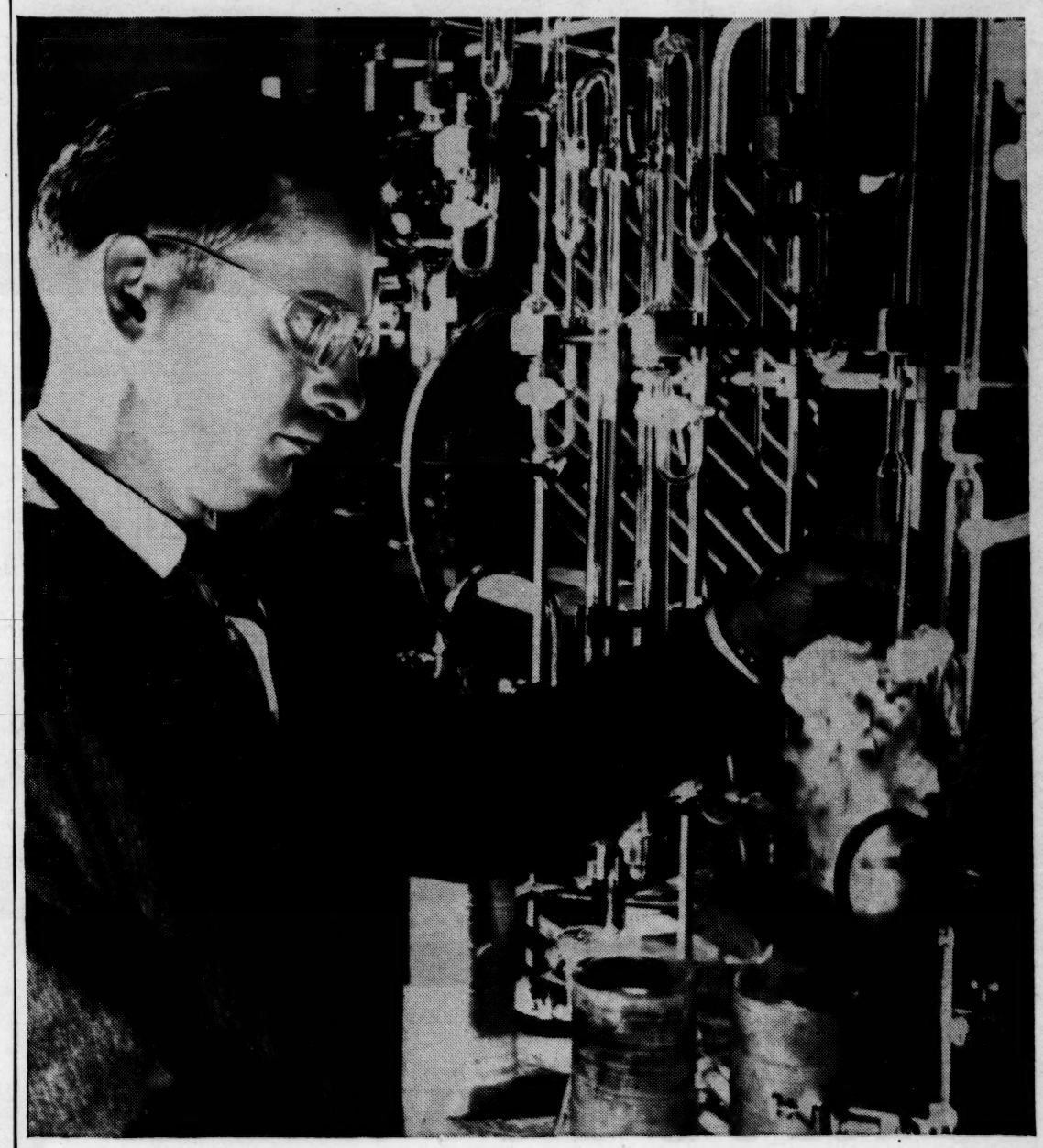
Contractor Services

Contractor services in maintenance and overhaul will be continued. The Army believes that its varying workload can be better handled by contractors who can adjust the size of their organizations to meet whatever needs arise.

Army space activities have been limited to one major project, the Courier communications satellite. Interest also is being shown in geodetic satellites which could improve the accuracy of maps.

GALLERY

PROPELLANT BRIEFS



Callery Chemical Company—the originator of boron fuels from test tube to tonnage production—continues to pioneer new avenues of research and development in the high-energy field. Teams of scientists at our Callery, Pa., laboratories are delving into new levels of advanced energy concepts. Objectives: to originate and improve solid and liquid fuels, mono-propellants and solid and liquid oxidizers for use in defense and space exploration missions.

This diversification of effort in the interests of National Defense can be helpful to you. A new laboratory and office in Encino, California, is providing closer liaison with the heart of the missile industry, and brings our capabilities to bear directly where they are most needed.

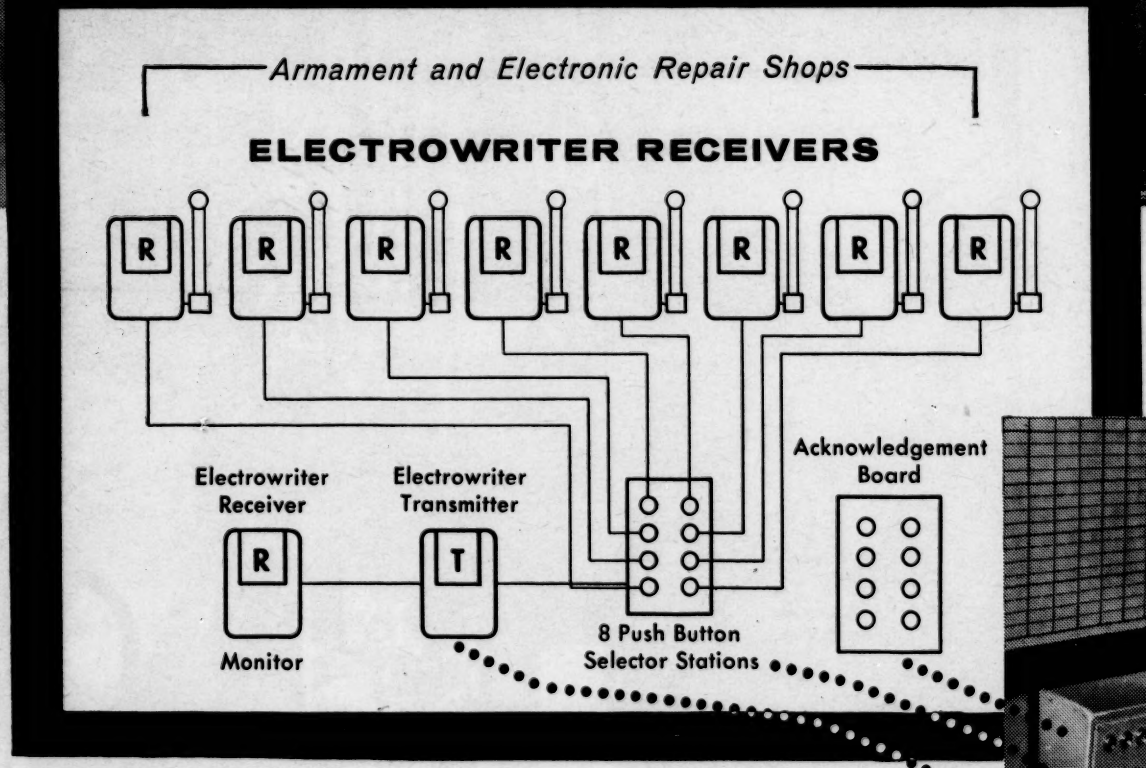
Callery provides Systems Management as well as subcontract capabilities for research and process development. We are particularly qualified in the fields of propulsion, oxidizers, energy storage, explosive and space manufacturing technologies.

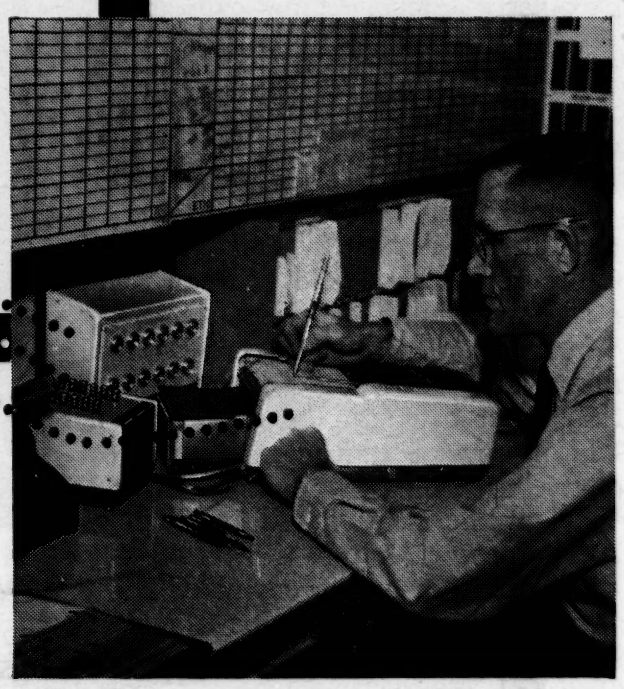
Our sales and research and development personnel are available at all times for technical service regarding the handling, shipping, storage and use of any of our products.

For information or technical service write Defense Products Dept., Callery Chemical Company, Callery, Pa.; or telephone Evans City, Pa., 3510, Ext. 455.

Circle Number 87 on Reader-Service Card

PHOTOS COURTESY
UNITED STATES AIR FORCE





Dispatcher

Here's how ADC *Says it in writing* AT HAMILTON AIR FORCE BASE

The Air Defense Command, Hamilton Air Force Base, cuts manpower and time in processing vital aircraft maintenance instructions through the use of Electrowriter Systems. Writing directly on an Electrowriter Transmitter, Central Maintenance transmits a description of the maintenance requested by an incoming aircraft. A pushbutton selector chooses the stations to receive the message. At Hamilton, there are nine receiving stations for Field Maintenance and eight receiving stations for Armament and Electronic services. Each shop concerned with the maintenance required receives the instructions instantaneously, *as they are written.*

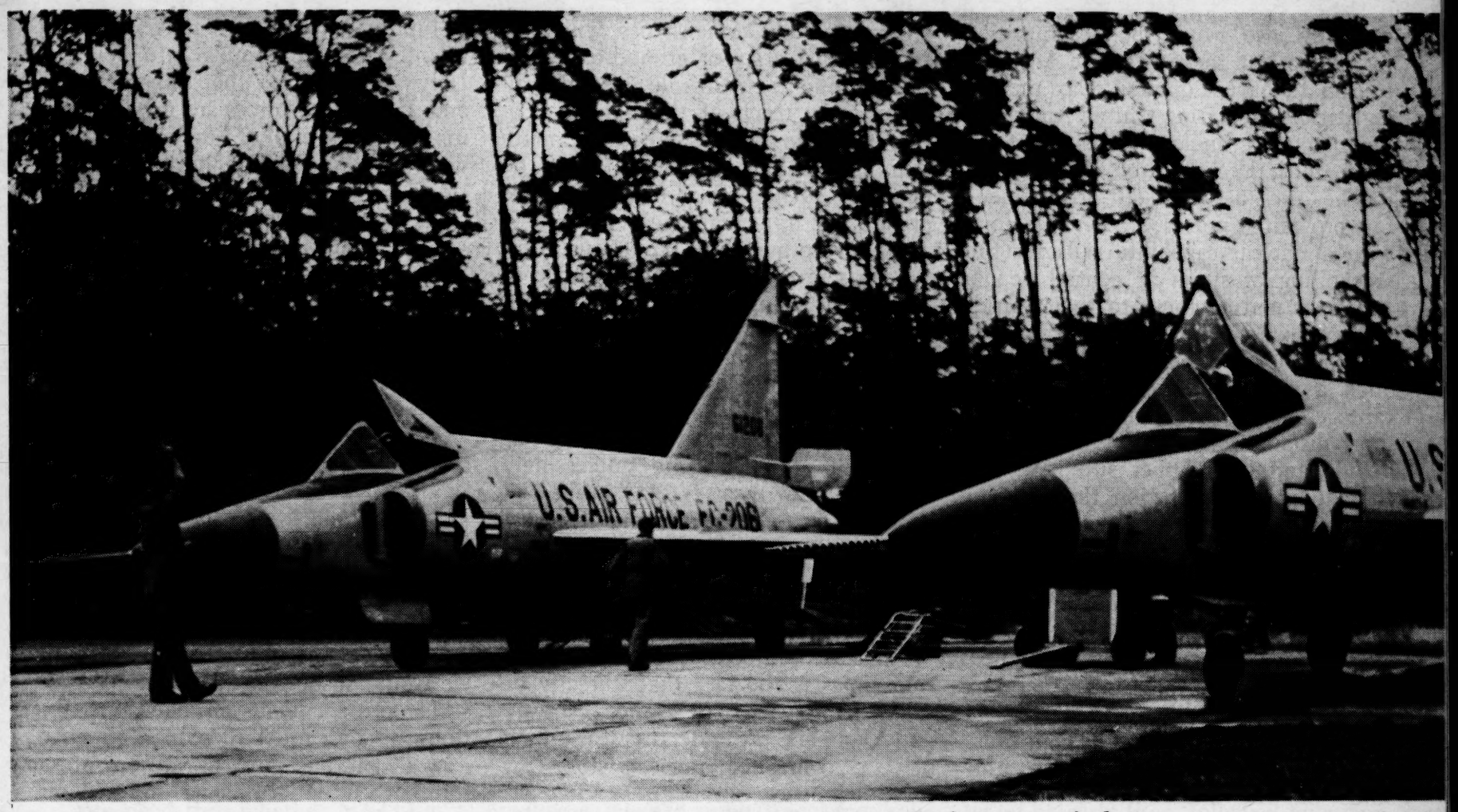
The Electrowriter System combines the speed of the telephone voice with the accuracy of written instructions. Only one writing of the instructions is needed throughout the entire system. Speed and accuracy is increased and manpower is saved.

Perhaps Electrowriter can bring added efficiency and speed to your communication system. Write for full information.

Electrowriter®
COMMUNICATION SYSTEMS BY
COMPTOMETER

COMPTOMETER CORPORATION • 5600 JARVIS AVENUE • CHICAGO 48, ILL. • SPRING 5-2400 • OFFICES IN PRINCIPAL CITIES

Circle Number 88 on Reader-Service Card



AIR FORCE Convair F-102 interceptors are readied for takeoff from a West German airstrip during a mock alert.

NATO Divided Over Weapon Transition

By Cecil Brownlow

Paris—Economic, technological and political storms that traditionally assail the planning efforts of the North Atlantic Treaty Organization are increasing in intensity as the Western "shield" moves to match its Soviet bloc foe in modern weapons.

For the moment, the 15 member-nations are deeply divided in a number of areas—whether to accept a U.S. offer that would make NATO a largely autonomous nuclear power; to what degree should a national force be submerged and its objectives geared toward the broad concepts of NATO; who pays for what, and why; how is the pie to be split in European production programs; where should the emphasis be placed in weapons development?

Some of these problems are not new, but the fissures are widening. Some are now being threshed out at the working levels, others will be solved at least temporarily at the annual NATO ministerial meeting at Oslo in May. But others will plague the organization through the current transition from a largely obsolescing force of Korean War vintage aircraft to modern equipment and beyond to the era of ballistic missiles and VTOLs.

Polaris "Suggestion"

The major political-technological-economic issue to be decided at the moment revolves around whether North Atlantic Treaty Organization members should buy and jointly control 100 Polaris missiles—a "suggestion" outlined late last year by the Eisenhower Administration.

Indications are that the "suggestion" has apparently met with the approval of the Administration of President John F. Kennedy.

Any acceptance of the "suggestion"

WEST GERMAN air force Lockheed F-104F two-seater employs afterburner for takeoff at start of a training mission.

probably also would be accompanied by an effort on the part of the Administration to have Congress relax present legislation stipulating that all American-manufactured nuclear stores must remain under U. S. control.

The present make-do arrangement for providing non-U. S. NATO units with a nuclear capability calls for the stockpiling of stores at central depots and then mating them to their carrier systems, which hopefully are located not too far away, as a crisis develops. Such a system has its obvious disadvantages—particularly in view of the short distances involved vis-a-vis Soviet missile and jet bomber sites and the consequent short reaction time to any surprise blow.

For the moment, however, West Germany appears to be the lone strong European proponent of the Polaris proposal, although it has the backing of Gen. Lauris Norstad, supreme allied commander in Europe, and other top NATO officials. Undoubtedly, Germany would have the most to gain from any change in U. S. law slackening the binds on the availability of nuclear stores.

During the second half of the 1960s, the German air force is scheduled to have on hand over 1,000 modern combat jets—all NATO committed and the strongest single power in Western Europe. The Germans also will have an imposing array of ground-to-ground and ground-to-air missile systems, all within easy reach of the Soviets. For this force to attain something more than minimal effectiveness, it will be necessary to have the nuclear weapons on site and immediately accessible.

On the other hand, and aside from the costs involved in any acceptance of the Polaris plan, France, Great Britain and the Scandinavian countries, in particular, seem hesitant to accept an idea that would make nuclear weapons available on a multi-nation basis.

Over-all, the present stockpiling arrangement will become increasingly hard to live with as NATO pushes its program for more and more dispersal of the forces on hand—the proposed Polaris systems, for example, would be spotted aboard mobile barges and railroad flat cars.

An added impediment to fast reaction times is the fact that, directly or indirectly, the laws of France, Norway and Denmark preclude the stockpiling of U. S.-controlled nuclear stores in these countries, although NATO officials insist that, should a crisis develop, "the French will have nuclear capability despite the base storage problem." Despite the political roadblocks, NATO's over-all nuclear posture should improve substantially during the year.

Jupiter intermediate-range ballistic missile sites are coming into being in Italy and Turkey; the Italian, Greek and Turkish air forces are now training in the delivery of tactical nuclear weapons and should have an operational capability within the near future.

In addition, the strike forces of the United States Air Forces in Europe will be strengthened this spring and summer with the introduction of the Republic F-105 fighter-bomber to the theater. West Germany will receive an initial F-104G capability during the year with aircraft delivered from the U. S. by Lockheed Aircraft Corp., and many German pilots have been trained in special weapons delivery techniques.

"All in all," one NATO general officer says, "we have a pretty substantial strike force. Its effectiveness, of course, will depend on its ability to withstand the forces against it.

"If the Communists hit us, no doubt we would sustain great losses. We are still too dependent on fixed installations, and, in order to remain effective —as a deterrent and as an operating force—it's essential that we improve our potential to survive. Our momentum will be very heavy in this direction over the next few years."

Another general officer adds:

"We're very vulnerable here. Take the Nike Ajax (anti-aircraft missile),

WHY AIR FORCE HAS ADOPTED MICROFILM FOR ENGINEERING DRAWINGS

Recently the Air Force issued new contract requirements of vital importance to companies that are doing—or intend to do—business with its various activities. In essence, the Air Force has made the use of microfilm mandatory for most engineering data and records relating to items delivered by contractors and their vendors.

The new requirements (MCP-71-77) incorporate standards and specifications issued earlier by the Department of Defense for its Engineering Data Micro-Reproduction System. The Air Force move is indicative of the importance of microfilm to the government in saving time, money, and space.

The Air Force is convinced that working with microfilm is easier than working with paper, that it is more efficient and costs less. Filmwork, in other words, is easier and more practical than paperwork for engineering drawings and records.

This is not news to the many industries that use microfilm today. They know that microfilm is a highly efficient and effective production communication tool. They know that microfilm can do many jobs much faster and much more accurately, with almost fantastic savings in time and money.

3M makes microfilm easy to use

for instance. You can't hide it, a missile could knock it out. The question is how many would survive?

"The big problem here is the simple one of survival against a rapidly growing threat with a virtually unstoppable means of attack."

On a more optimistic note, however, he says that "right now, with what we have in central Europe, I don't think he (the Soviet Union) has a chance of taking Europe. And, if he shifts his power, we'll get word of it and shift accordingly."

Survival in an attack, officers here agree, means dispersal. Plans, which NATO headquarters hope the member nations will accept, include the dispersal of aircraft to hardened sites from which they could be catapulted by zero-length launchers. Italy, for example, has shown some interest in adapting North American Aviation, Inc.'s F-100 zero-launch technique to the Fiat G.91 close-support fighter.

Such a plan, a NATO planning officer agrees, "is costly, but it's not prohibitive. I'm convinced some of the nations will go for it." And, he adds:

"We need this, whether NATO gets its own nuclear weapons or not. If it does, it will help our problem quite a bit. If it doesn't, we can live with it."

In other areas, NATO also is moving ahead in spite of the political buffets that present obstructions to its policy machinery.

Standardization of equipment, still an anathema to some countries, is beginning to make significant inroads, and more and more bilaterals are being drafted for the joint development and production of hardware—a necessity in some cases because of the high costs and complexities of modern weapons systems that prohibit any one nation from going it alone.

The multi-nation F-104 production program, although not an official NATO project per se, is beginning to swing into gear after a series of delays, and the first aircraft is due off the line later this year. Licensed production plans for the Hawk anti-aircraft and Sidewinder air-to-air missiles also are progressing. Breguet is receiving components from other European contractors and fabricating the prototype of NATO's Atlantic turboprop anti-submarine warfare patrol aircraft.

A forward scatter communications net along the 4,000-mi. NATO periphery from Norway to Turkey will become fully operational within the near future, reducing reliance upon sometimes reliable land lines and national telephone and teletype systems. "If a repeater (on a national system) goes out on a Saturday afternoon," one official complains, "the guy who can fix it has gone home for the week-end, and you've had it until Monday."

Effective and secure communications still remain a problem, however, and the need for further developments in this field is receiving the personal attention of Dr. Jerome B. Wiesner, President Kennedy's scientific adviser.

Logistics is still a national function, but the NATO maintenance supply services agency at Chateauroux, France, with large stocks of spares, is pushing the move towards both standardization and a logistics network.

Even in the drafting of agreements on future needs, the nations are slowly drawing closer together, particularly when compared with the bitter backbiting of a few years ago over the selection of a common close-support fighter. The fighter chosen, the Fiat G.91, has been selected by two nations thus far—Italy and West Germany.

Although not without delays and a maximum of maneuvering for position by the major nations involved, the NATO V/STOL close-support fighter program apparently is on the threshold of progress, and a request for bids may be let by early June, followed by a competition for a V/STOL transport.

If present plans remain in force, production will be on a multi-nation basis, and more than one country will buy.

In connection with the V/STOLs, a

When data is on microfilm in FILMSORT Aperture Cards, facts that speed production are at your finger tips in just 90 seconds. And with a THERMO-FAX "Filmac" Reader-Printer you can take more than a look—you can take an enlarged copy in seconds.

Microfilm really became practical for industry only a few years ago when Minnesota Mining and Manufacturing Company introduced THERMO-FAX "Filmac" Reader-Printers. For the first time, the advantages of a reader and a printer were combined in one compact, low cost unit. Today there's a "Filmac 200" Reader-Printer that has a huge viewing screen, simple pushbutton operation, makes copy after copy in 18" x 24" size or half size prints of engineering drawings and data from microfilm in FILMSORT Aperture Cards. A "Filmac 100" Reader-Printer delivers 8½" x 11" copies in seconds, too.

FILMSORT Aperture Cards and "Duplicard" Copy Cards long used by government and industry are designed to meet military specifications and standards. These are the punch cards that make microfilm so easy to file, find, and use.

FILMSORT Microfilm Copiers, Mounters, and Readers are designed exclusively for FILMSORT Aperture Cards. They are engineered to make your microfilm system profitable.

Get the proof!

For complete information on how 3M makes microfilm so easy to use, for details about military microfilm standards and specifications, and for a free copy of "How to Put Microfilm to Work," mail this coupon today.

Please rush me ☐ information on how 3M makes microfilm so easy to use, ☐ details about the Department of Defense specifications, ☐ free copy of "How to Put Microfilm to Work."

Name_____ Title_____

Company_____

Address_____

City_____ Zone___ State_____

3M BRAND MICROFILM PRODUCTS

THE TERMS "THERMO-FAX" AND "FILMSORT" ARE REGISTERED TRADEMARKS OF MINNESOTA MINING AND MANUFACTURING COMPANY ...WHERE RESEARCH IS THE KEY TO TOMORROW

Dept. FBV-3131 St. Paul 6, Minn.

Circle Number 91 on Reader-Service Card

"It is believed that aircraft in the world performance of the T

The Right Hon Harold Watkinson, MP, British Minister of Defence, speaking at Weybridge, on Friday, 7th Oct 1960

...AND BRISTOL SIDDELEY

British Aircraft Corporation have recently received an order from the Ministry of Aviation for a number of TSR 2's. One of the most advanced military aircraft ever to be designed, the TSR 2 will be used in tactical strike and reconnaissance roles with a wide range of weapons, including nuclear. It will: (1) reach twice the speed of sound at altitude; (2) be capable of high subsonic speeds at ground level; and (3) have short take-off and landing capabilities from inferior surfaces.

The Minister of Defence said, when announcing the order: "It is believed that no other single aircraft in the world can match the performance of the TSR 2 in all three respects." The TSR 2 will be powered by the Bristol Siddeley Olympus turbojet.

The Bristol Siddeley Olympus has proved itself in service to be one of the most successful turbojets ever built. Its truly astonishing built-in potential has been strikingly demonstrated by the threefold increase in power from the 11,000-lb thrust of the original production engine to the 33,000-lb thrust with reheat of the latest version. The Olympus, which has already helped the Avro Vulcan V-bomber to achieve its outstanding performance, embodies all the qualities essential for the efficient propulsion of a supersonic aircraft: high power at high altitude; remarkable handling characteristics; extremely low fuel consumption; great operational flexibility; a long overhaul life; and the highest power for its weight of any high-thrust turbojet. The Olympus is eminently suitable for Britain's civil supersonic transport.

BRISTOL SIDDELEY ENGINES LIMITED

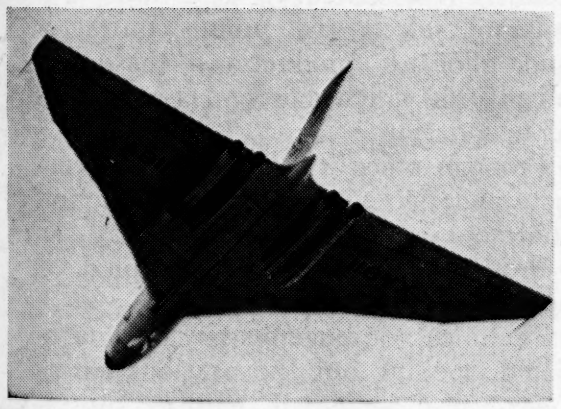
BRISTOL AERO-INDUSTRIES LIMITED, 200 INTERNATIONAL AVIATION BUILDING, MONTREAL 3, CANADA

no other single

ld can match the

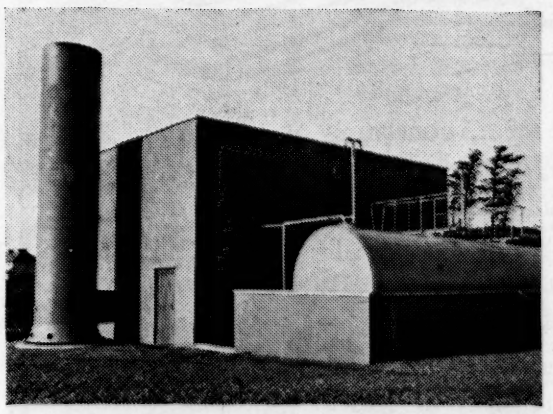
TSR 2..."

SUPPLY THE POWER



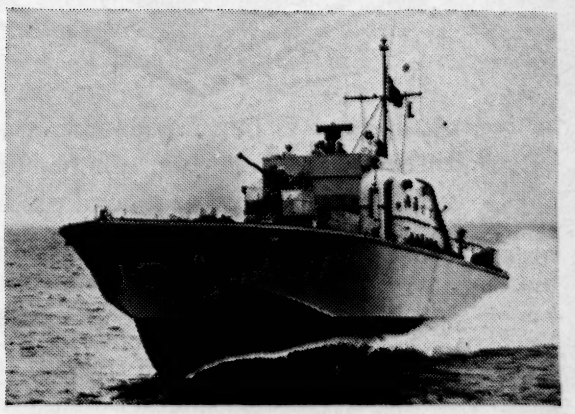
POWER FOR THIS

The Bristol Siddeley Olympus high-thrust turbojet powers the Avro Vulcan V-bomber—gives this delta-winged spearhead of the RAF's deterrent force an outstanding performance. Current Olympus versions deliver 20,000-lb thrust dry. Even more advanced Olympus versions are rated at 33,000 lb with reheat.



...AND THIS

The Bristol Siddeley Industrial Proteus gas turbine engine powers a 3-megawatt turbo-generator. Designed for peak-lopping, stand-by generation, or any other intermittent use, this new pocket power station, two of which are in service, delivers full power within 2 minutes of a cold start for a lower capital cost than any other type of installation.



...AND THIS

The Bristol Siddeley Marine Proteus powers the world's fastest naval vessels, the "Brave" class Royal Navy patrol boats, built by Vosper Ltd. Three Proteus deliver a total of 10,500 hp—propel these 96-ft boats at over 50 knots. The Marine Proteus is quick-starting and reliable and holds large reserves of power for acceleration.

TEL: UNIVERSITY 6-5471

TEST EQUIPMENT DESIGN

Electronic diagnosis? Can you design and build equipment to isolate operational malfunctions in complex electronic and electro-mechanical systems? Required: experience with transistorized circuitry, digital or analog computing techniques, and/or sub-miniature electro-mechanical devices and associated electronics. Write to Mr. Donald Krause.

LITTON SYSTEMS, INC. Guidance & Control Systems Div.
Beverly Hills, California

PROBLEMATICAL RECREATIONS 57

A, B, and C participate in a track meet, consisting of at least three events. A certain number of points are given for first place, a smaller number for second place, and a still smaller number for third place. A won the meet with a total score of 14 points; B and C are tied for second with 7 points apiece. B won first place in the high jump. Who won the pole vault? —*Contributed*

This year's IRE Show promises to be jumping with data-packed displays. Among them, the many divisions of Litton Industries. Hope to count our readers in the estimated 60,000 attendance. See you in New York, March 20-23rd.

ANSWER TO LAST WEEK'S PROBLEM: The logic is tricky, but the rental was $1.50 per horse for the first month, $1.20 per horse for the second month, and $1.00 for the third. A owed $4.50 for the first and $4.80 for the second month. B owed $6 for the second and $6.00 for the third. C owed $7.50 for the first and $7 for the third.

LITTON INDUSTRIES
Beverly Hills, California

Circle Number 94 on Reader-Service Card

● NATO

"20 projects" program to delve into the most needed developments by the NATO nations as a whole also has evolved, stemming from a 1959 United Kingdom recommendation. At present, only major hardware—and usually weapons systems—is considered, although components may enter the picture at a later date.

The program has undisputed merit, but the cumbersome selection and development process through which it has to survive gives some indication of the red-tape-slashing exercises still needed within NATO—as elsewhere:

- **Proposal is made** by an individual country, the NATO international staff or NATO military authorities.
- **Detailed report on proposal** is presented to the NATO armaments committee, second highest-ranking permanent body under the NATO council.
- **Committee, if it accepts** the merit of the proposal—or sometimes if only two countries agree—usually appoints one of a number of types of working groups to make a detailed study—i.e., an "exploratory ad hoc mixed working group" ("mixed" means both civilian and military representatives); etc. In some cases, however, there is no need for a working group since the proposal may fall into the realm of one of 16 NATO standing groups of experts or of one of their 29 subgroups.
- **Group finally selected** studies the proposal, canvasses the countries that are seriously interested and drafts a report on the numbers that probably would be built if ordered into production and just how the production should be divided among the participating nations. "There is," one official says, "a lot of give and take here."
- **Organization which will effectively act** as the project's board of directors is organized, with each participating country represented.
- **Board selects the prime** contractor and allocates production—"these are nice words which represent a great deal of negotiation."
- **Program office is established** to negotiate and sign a preliminary production contract.
- **Production licenses are obtained,** if necessary.
- **Technical arrangements are negotiated,** spelling out the previous agreements in more detail, naming subsystem manufacturers, etc.
- **Main production contract is negotiated,** and pilot production is begun.
- **Test program is begun.**
- **Full production gets under way.**
- **Training programs for crews** are established, if necessary.
- **Follow-on support and maintenance** programs are established.

The process is long, and cooperation is sometimes not enthusiastic, but both are improving. One harried NATO

development official recently explained:

"You have 14 nations here (Iceland is a NATO member but doesn't participate in weapons development programs), each with a self-contained defense force, who only recently began to look outside their own borders. By now, it's pretty clearly accepted that the ideal situation is standardization. The quarrels revolve around what's needed.

"There are different ideas on how best to defend yourself and what you need to do it. Some countries are afraid to take too strong a stand on new weapons or standardization because of their proximity to Russia. Others insist on strictly nationalistic programs.

"Things are much better but, as an example of some of the problems—in December, 1956, five countries decided to coordinate follow-on support for a common aircraft. One country came with money; the only thing the others had was a sales pitch. The one with money went home mad, and it took us three years to get it back on the team.

"And each country generally has a definite interest in producing for itself. Many have national laws compelling them to give preference to the national industry.

"Essentially," he concludes, "what we are accomplishing is a slow erosion of these countries' fears. When this happens, standardization and cooperation will follow."

The technological and political disputes have been heightened by the public fears, first expressed in the declining days of the Eisenhower Administration, over the growing U.S. dollar loss overseas, the advent of a new administration of unknown caliber, and the resultant rumors and open concern in Europe as to whether NATO's strongest partner would remain firm.

West German Chancellor Konrad Adenauer also has been clearly upset by Gen. Charles de Gaulle's insistence upon building a purely national force with an independent nuclear capability, and by the fact that France now has only two cadre divisions earmarked for West European defense—as opposed to the four front-line divisions to which it is committed.

The front-line divisions are, of course, in Algeria, and NATO planners are looking toward the possible settlement of the Algerian crisis with a more than academic interest. One top NATO officer here says, "if the Algerian troops ever come back, things will be much better all around."

Despite the uneasiness sometimes displayed at the upper echelons, France and Germany have been growing closer together. German aircraft, with French permission, fly over the breadth of France almost daily on training missions. German troops, with little territory available for such purposes in their homeland, conducted maneuvers on French soil last year with a minimum of dispute.

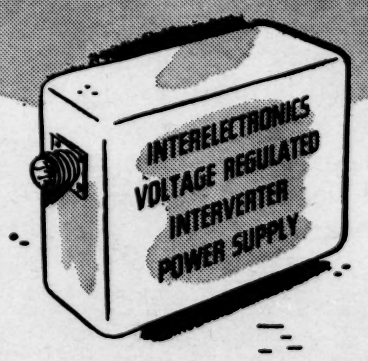
The dollar drain from the U.S. and just what a resurgent West Germany should do to help curb it also has created some verbal transatlantic harping but, within NATO, Germany seems willing to accept a larger share of the burden as its military strength grows to 12 divisions and a 28-wing air force.

In NATO's multilateral financing program, for example, which is largely concerned with civil works programs such as airfields, communications centers, access roads, etc., Germany has agreed to boost its contribution from 13.72% to approximately 20%, while the U.S. share will decline from 36.98% to 30.85%. Great Britain and France also are boosting their funding effort in this category.

For all the apparent strains, arguments and hassels, NATO has achieved its mission. Referring to the organization's role since its formation in 1949, a NATO manual proudly notes:

"Soviet expansion westward, which was proceeding at an alarming rate during the years following the second World War, has been halted. Not one square inch of territory in Europe has fallen under Soviet domination since the signature of the treaty."

PROVEN RELIABILITY—
SOLID-STATE POWER INVERTERS
over 260,000 logged hours— voltage-regulated, frequency-controlled, for missile, telemeter, ground-support, 135°C all-silicon units available now—



Interelectronics all-silicon thyratron-like gating elements and cubic-grain toroidal magnetic components convert DC to any desired number of AC or DC outputs from 1 to 10,000 watts.

Ultra-reliable in operation (over 260,000 logged hours), no moving parts, unharmed by shorting output or reversing input polarity. Wide input range (18 to 32 volts DC), high conversion efficiency (to 92%, including voltage regulation by Interelectronics patented reflex high-efficiency magnetic amplifier circuitry).

Light weight (to 6 watts/oz.), compact (to 8 watts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltage regulation (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment magnetostrictive standards or to 0.0001% with fork or piezoelectric standards).

Complies with MIL specs. for shock (100G 11 mlsc.), acceleration (100G 15 min.), vibration (100G 5 to 5,000 cps.), temperature (to 150 degrees C), RF noise (I-26600).

AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

Now in use in major missiles, powering telemeter transmitters, radar beacons, electronic equipment. Single and polyphase units now power airborne and marine missile gyros, synchros, servos, magnetic amplifiers.

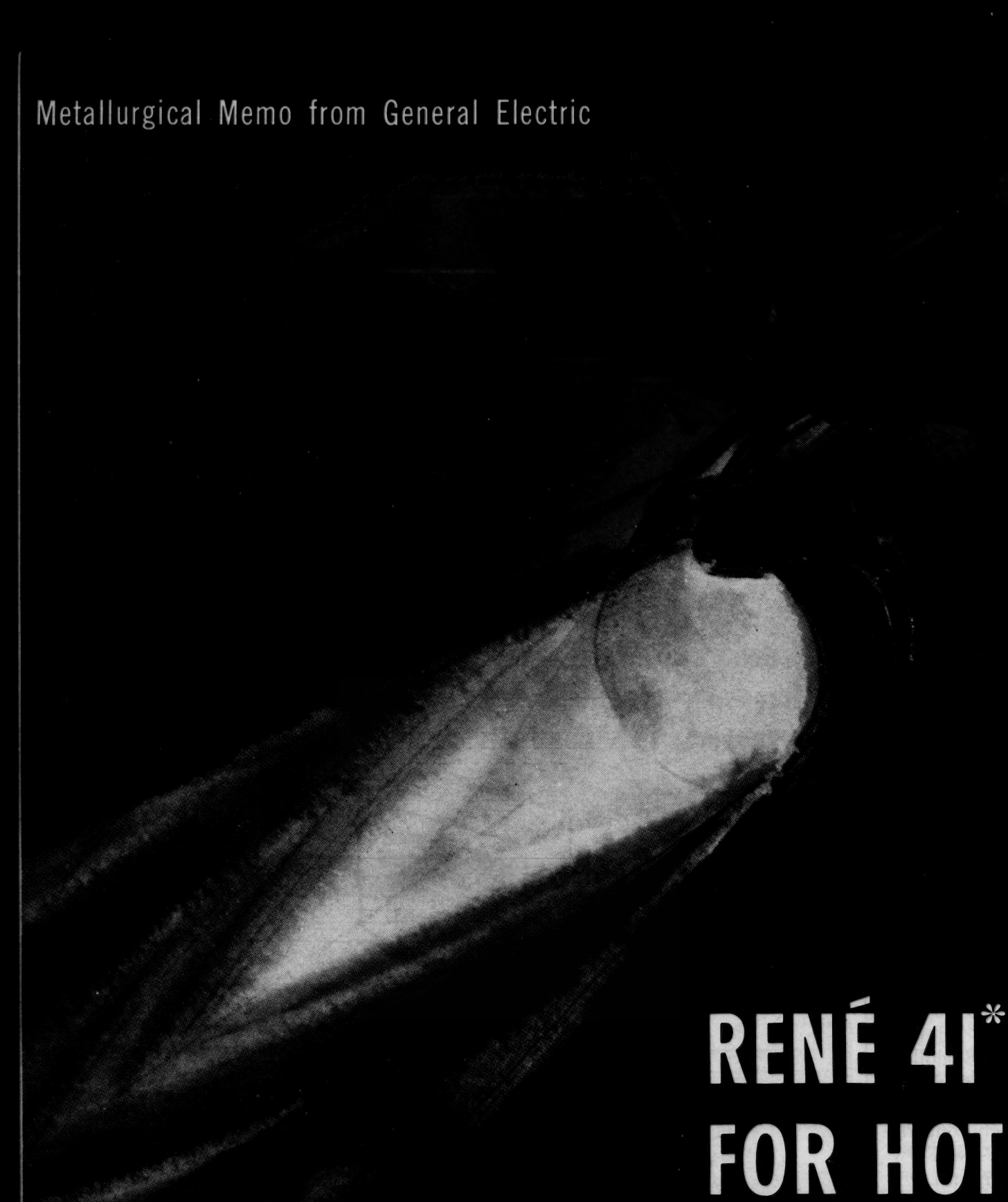
Interelectronics—first and most experienced in the solid-state power supply field produces its own all-silicon solid-state gating elements, all high flux density magnetic components, high temperature ultra-reliable film capacitors and components, has complete facilities and know how—has designed and delivered more working KVA than any other firm!

For complete engineering data, write Interelectronics today, or call LUdlow 4-6200 in New York.

INTERELECTRONICS CORPORATION
2432 Grand Concourse, New York 58, N. Y.

Circle Number 95 on Reader-Service Card

Metallurgical Memo from General Electric



RENÉ 41* FOR HOT JOBS!

René 41 is a super alloy developed by metallurgical engineers at General Electric especially for high-temperature applications. Prepared by a vacuum-induction-melting process, René 41 combines light weight and top strength with high-temperature resistance (1600° to 1800° F.). In addition, René 41 is extremely ductile; corrosion- and oxidation-resistant.

This super alloy can be easily forged, welded, or formed; it is available in sheets, plates, bars, billets, flats, wire, or castings. Can we help *you?* Write: *Metallurgical Products Department of General Electric Company, 11199 East 8 Mile Road, Detroit 32, Michigan.*

**René 41 is a trademark of the General Electric Company.*

METALLURGICAL PRODUCTS DEPARTMENT

GENERAL ELECTRIC

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • MAGNETIC MATERIALS
THERMISTORS • THYRITE® • VACUUM-MELTED ALLOYS

Soviets Wield Nuclear, Small War Threats

Sino-Soviet threat is expanding in scope and stiffening in strength as the Communist bloc pursues its long-term goals of economic and political penetration of non-Communist countries, using the spearhead of brush fire war to penetrate where other methods fail and casting a longer shadow of nuclear missile blackmail across the world.

Implicit in the growing truculence of both Communist China and the Soviet Union in its dealing with the western world and neutrals during the past year has been the growing Soviet capability in nuclear weapons delivery via jet bombers, intercontinental ballistic missiles and submarine-launched missiles, plus a growing capability to blunt the penetration of any U. S. nuclear counterstrike which would now rely almost completely on subsonic manned aircraft.

The USSR probably will try to parlay this combination of its own nuclear strike force spearheaded by its ICBM and IRBM deployment and its greatly increased air defense effectiveness against U. S. subsonic bombers into a policy of nuclear stalemate that will make the overwhelming Soviet superiority in non-nuclear conventional forces the key piece on the international chess board.

If the Soviets are successful in gaining acceptance of the idea of nuclear stalemate, either through a formal ban on nuclear weapons or merely by imposing a psychological reluctance to use nuclear weapons on the western alliance, they can be expected to light brush fire wars in several spots before the year is ended. With several of these brush fire wars ignited in widely separated parts of the globe—such as Laos or Formosa in the Orient, Israel in the Middle East and the Congo in Africa—the currently limited aerial logistic support resources of the U. S. would be severely strained if not snapped by the demands of simultaneous support. The limited war forces now existing in the west would be badly outclassed without resort to tactical nuclear weapons.

New Technologies

All Soviet expansionist foreign policy is conducted against the basic backdrop of military strength, which has been growing at a significant rate since the Russians embraced the new technologies of supersonic aerodynamics, nuclear fission and rocket propulsion. Although the Soviets still maintain the largest military manpower in the world in service, their switch to the new technologies has enabled them to increase the over-all power and effectiveness of their military forces while siphoning off manpower to the badly overstrained civilian labor force.

Soviet military policy has been traditionally defensive, but with the advent of the ICBM there has been a noticeable switch in Soviet military philosophy to exploring the advantages offered by the intercontinental missile for a devastating surprise attack on a major foe. The ICBM apparently holds little attraction for Soviet military leaders as a retaliatory or counterstrike weapon, as it does for both U. S. military and political leaders. The Soviets see the ICBM primarily as an instrument of nuclear blackmail, as their "missile rattling" episodes from the Suez attack to the U-2 incident clearly reveal, and as a weapon with which it may be possible to achieve hitherto unprecedented success with a surprise attack that could effectively cripple a major antagonist with a single, massive 30-min. salvo.

Pacific ICBM Show

To establish the validity of their ICBM capability, the Soviets fired a series of shots over ranges up to 8,000 mi.—impacting in the Pacific Ocean southwest of Hawaii, where their reentry and accuracy characteristics could be measured by U. S. instrumentation in the area, as well as by a trio of Soviet range instrumentation ships that became familiar fixtures in the Pacific during 1960. These shots demonstrated the Soviet ICBM has sufficient accuracy to put a multi-megaton warhead close enough to any major urban or military target to destroy unhardened installations and has range sufficient to reach any point in the United States from any point in the Soviet Union (7,500 stat. mi.).

Political squabbles over U. S. intelligence estimates have tended to obscure the real military significance of the Soviet missile capability, which nobody denies is rapidly growing to significant force.

This growth may trigger a basic switch in Soviet military policy aimed at forcing the nuclear stalemate philosophy into a nuclear ban that would pave the way for brush fire war operations all along the Soviet perimeter or may crystalize the philosophy of successful offensive war through an ICBM nuclear surprise attack.

Key period will come in the next several years when the Soviets have the possibility of developing an ICBM and submarine-launched missile salvo capability that would destroy the unhardened Air Force Atlas sites plus a majority of Strategic Air Command bases before the bombers could get off the ground, leaving only a few Titans and Atlases from hardened sites and a relatively small bomber force to retaliate against the USSR.

There is considerable "raw" intelligence available on the scope and character of the Soviet ballistic missile build-up, but, during the process by which "agreed national intelligence estimates" are arrived at through the bureaucratic inter-agency process, this original data is reduced to the lowest common denominator which each participating agency for its individual reasons will accept. Some military leaders feel this process leads to an ultra-conservative view of the Soviet capability, while sound military planning should be based on the maximum possible Soviet capability in any particular field.

Soviet leaders, including Premier Nikita Khrushchev, have openly boasted that their ICBMs are now deployed in dispersed and camouflaged sites and are capable of hitting targets in any nation that "provokes" the Soviet Union or its allies.

Continued Soviet development of rocket engines producing up to 1-million-lb. thrust gives their ICBMs the capability of using multi-weapon warheads which can spread several multi-megaton bombs over a broad target area, such as a large city or a dispersed ICBM site, and also gives them the capability of carrying and launching decoy warheads to confuse the computers of an anti-ICBM defense system.

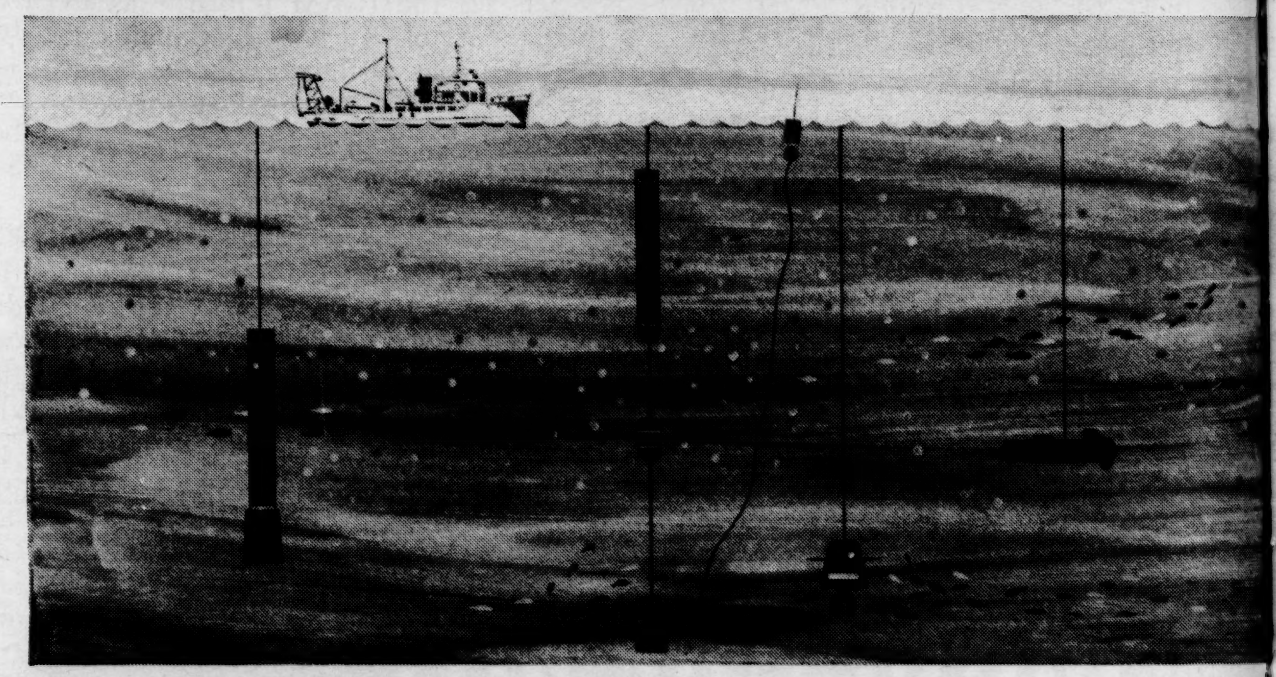
Major build-up in the Soviet Union's air defense system is apparently aimed at substantially increasing the attrition rate of the SAC and Navy subsonic bomber force that could penetrate to Russian targets on a retaliatory strike. With this kind of a balance in nuclear strike exchange, the prospect of major nuclear war might look attractive to Soviet planners.

Air Defense Program

Soviet air defense program involves installation of new longer range and more modern radars in depth along the USSR perimeter; installation and operation of modern fighter control centers; re-equipping of air defense squadrons with new supersonic interceptors carrying airborne radar and air-launched missiles; deployment of an improved second generation of ground-to-air defensive missiles, and linking of the USSR air de-

THE WONDER MATERIAL FOR ASW IS PLASTICS

...AND THE COMPANY FOR PLASTICS IS ZENITH



Plastics will not corrode. It will not undergo electrolysis. It is non-magnetic. It is more difficult to detect. And reinforced-plastics has an amazing strength, even at great depths.

Zenith has the extensive engineering knowledge, well-equipped reinforced-plastics laboratories, electronic test facilities, and large production capabilities to form resin-bonded glass fiber into virtually any marine component imaginable. Zenith has more than 15 years experience in pioneering new techniques and production processes in plastics.

Zenith has developed its own method of end-over-end filament winding, a process which gives a high strength-to-weight ratio. Zenith has equipment which makes it possible to mold reinforced plastics into huge and highly complex shapes. These are the reasons Zenith has the versatile capability to produce marine components *better* in plastics. This is why Zenith was the company called on to build the first all-plastics LCVP for the Navy.

Consider the many benefits of plastics in your undersea, ASW, and marine projects before you seal the design. Remember, the wonder material for ASW is plastics...and the company for plastics is Zenith.

Minnesota Mining and Manufacturing Company

ZENITH PLASTICS DIVISION

1600 WEST 135TH STREET, GARDENA, CALIFORNIA

3M COMPANY

fense system with radar networks in China and other perimeter satellite countries.

Looming beyond the current development of the Soviet missile spear and its air defense shield is a growing capability to apply space technology to military problems. Soviet success in hurling seven ton payloads into orbit and in launching a Venus probe from the parking orbit of a satellite has already created a psychological impact in the world, demonstrating that military space potential already exists and can be expected to be developed soon. Initial Soviet military space capability probably will be for reconnaissance. All of the Sputniks after the first two have had ample capacity for reconnaissance equipment, and it is unrealistic to suppose that because the Soviets have made no mention of these experiments, they have not conducted reconnaissance of the earth from their satellites.

Some military opinion maintains that the Soviets do not need a space reconnaissance capability because of their excellent world-wide espionage network and because so much information on U. S. military installations is available publicly. This overlooks the two essential supporting systems required for an effective ICBM weapon system—precise geodetic information for missile guidance systems and target pattern reconnaissance that is fresh enough to be valid for a mass missile launch. An example of the latter requirement would be satellite reconnaissance that showed most of SAC's bombers were not at their normal bases, which would cancel the effectiveness of a missile strike at those bases and require determining the new location of the bomber groups before an effective missile strike could be launched.

Psychological Weapon

It is also likely that the Soviets will exploit the psychological possibilities of bombardment satellites, particularly after they successfully send a man into orbit and return him to earth. The argument over whether the bombardment satellite might be an inefficient method of delivering a nuclear warhead may become academic in view of the psychological impact such a device could offer as diplomatic leverage.

Looking even farther ahead, it is logical to expect that the Russians will attempt to land men on the moon and establish some sort of lunar activity, although it will be initiated under the guise of purely "peaceful" scientific exploration.

Biggest improvement in the capabilities of the massive conventional land and air forces of the Soviet Union has come with the development of a sizable fleet of turbojet and turboprop-powered

FOR
LIGHTNING-FAST INDICATION...
WITH CONTROLLABLE RETENTION

DU MONT DIRECT-VIEW STORAGE TUBES

a DVST to satisfy your application needs

... from aircraft radar to ground control. Brighter, flicker free displays, retained—for seconds or hours. Brightness permits excellent readout even in high ambient light conditions—such as in aircraft cockpits. Continuous tracking of a moving object—in the air or on the ground—made crystal clear by superimposing information. These are only a small portion of the advantages provided by Du Mont Direct-View Storage Tubes. For any aeronautical DVST requirements—look to experience and depth of line—look to Du Mont.

WRITE FOR COMPLETE DETAILS...

FEATURES

- Selection of sizes from 2¾" to 21"—including electrostatic types
- Brighter, flicker-free displays
- Information superimposed on other information for dimensional observations
- Controlled and variable persistence
- High readout capability—even in high ambient light conditions

DU MONT
ALLEN B. DU MONT LABORATORIES, Clifton, N. J.
Tube Sales Department
DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
DU MONT INTERNATIONAL DIVISION • 515 MADISON AVE., NEW YORK 22

Circle Number 99 on Reader-Service Card

THE CHERRYLOCK TEAM

The Standard Cherrylock

Top Performance Through the entire range of Diameters, Grips, and Materials

The Bulbed Cherrylock

Specifically for Thin Sheet and Double Dimple Applications— Even Greater Strength in the Short Grip Ranges

Only the Cherrylock "2000" Team Gives you All These Advantages

- Mechanically Locked Stem
- Flush Fracture (No Stem Trimming)
- Positive Clamp-up
- Full Grip Range
- Complete Hole Fill
- Positive Visual Inspection (Grip Marked on Head)

A-286 Stainless Steel—Monel—Aluminum

The Cherrylock* "2000" series team offers the finest, most adaptable aircraft rivets yet developed. Maximum joint strength and reliability are obtained by using the Standard Cherrylock and the Bulbed Cherrylock to cover the entire range of applications. The Bulbed Cherrylock for short grips and double dimple, the Standard Cherrylock in the longer grips. Both types are installed with the same H-610 series pulling head, using existing Cherry guns.

Higher joint strength allowables, close blind side clearance, and the widest grip range available—only with the Cherrylock Team—result in better fastening at lower cost. The Cherrylock Team provides the strongest mechanical lock—flush fracture rivet available. Positive visual inspection after installation—with grip length marked on the rivet head—is offered only by the Cherrylock Team.

* * *

For technical data on the Cherrylock Team of rivets, write Cherry Rivet Division, Townsend Company, Box 2157-N, Santa Ana, Calif.

*Patent No. 2931532

CHERRY RIVET DIVISION

Townsend Company

In Canada: *Parmenter & Bulloch Manufacturing Company, Limited, Gananoque, Ontario*

Circle Number 100 on Reader-Service Card

transports that gives these forces both greatly increased speed in their mobility and substantial extension of their range of operations through air transportability and supply. Basic workhorses of the military transport fleet are the turboprop-powered Antonov series, An-4, An-10 and An-12, all designed for truckbed loading and operation from small grass or dirt fields.

The Soviet jet transport fleet also is playing an important role in the political and economic penetration of non-Communist countries, providing swift and secure communications directly from Moscow to the key cities in the non-Communist world.

The latest Soviet bid to obtain commercial landing rights in New York for a route that would include Havana as an intermediate stop is an example of how the Aeroflot routes follow closely the path mapped for political penetration.

In addition to providing a fast and secure communications line to the pro-Soviet Castro government in Cuba, Aeroflot's Moscow-Havana route would also provide the vital link for expansion of the Communist airline throughout Latin America.

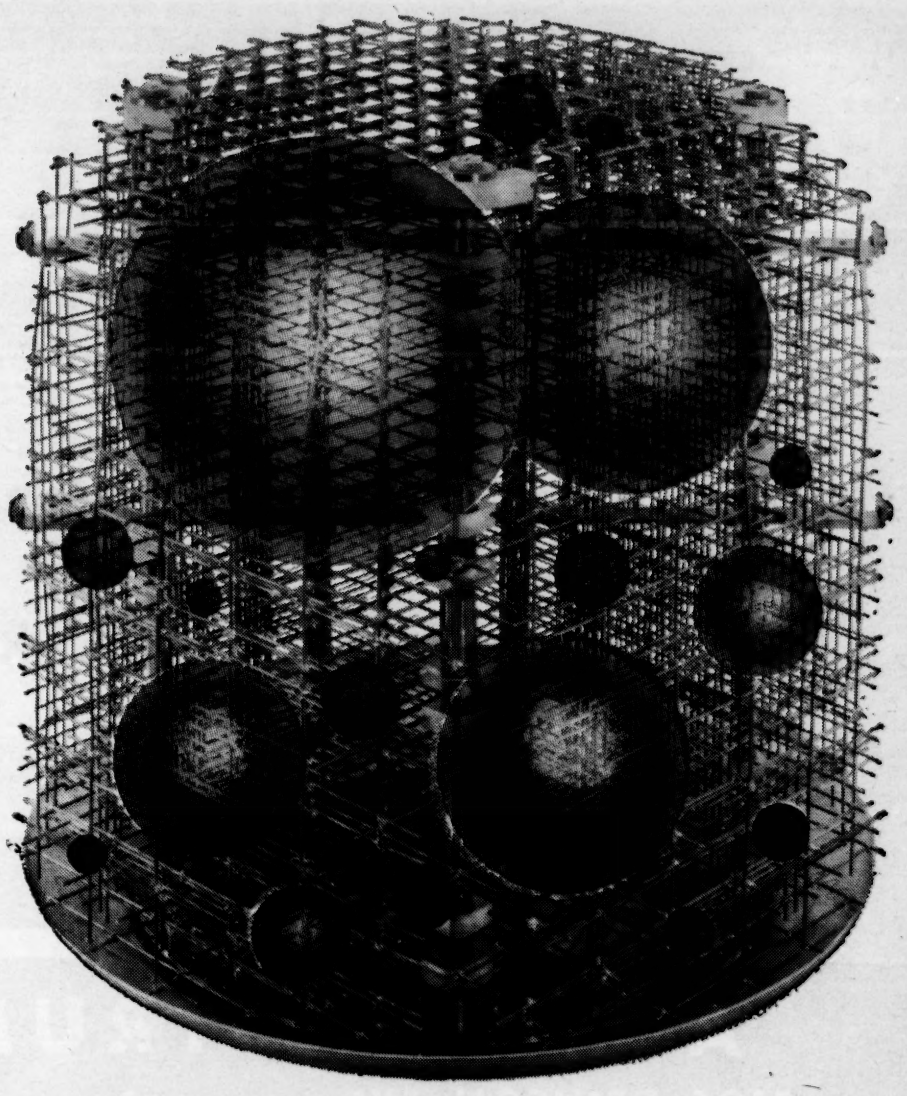
The Soviet transport fleet also is providing an economic entree in many countries where development of an air transport system is either a matter of economic necessity or a symbol of intense national pride. The Il-18 turboprop transport has proved the best export item from the Soviet transport fleet, although the An-12 and Il-14 also have been sold to nations outside the Communist bloc.

Soviet aircraft and helicopter exports have usually been accompanied by the dispatch of Russian technical missions to the purchasing countries and by invitations to train native technicians in the Soviet Union—a double-edged weapon of political penetration.

Military aircraft are also on the increasing Soviet list of exports to non-Communist countries. Latest development in this area saw a squadron of MiG-17 jet fighters exported to Morocco, while further deals are being negotiated for MiG fighters and Ilyushin transports with Indonesia and the United Arab Republic. Cuba has also been a heavy recipient of Soviet arms, including MiG-17 fighters.

Soviet Army has been through two major weapon equipment cycles since the end of World War II. It is now heavily mechanized, including mobile, tracked missile launchers, airborne tanks and self-propelled guns, and features a large airborne force. The Army missile arsenal is equipped with a wide variety of types including battlefield missiles with ranges beginning at 10-15 mi. and extending to 250-500 mi., with another

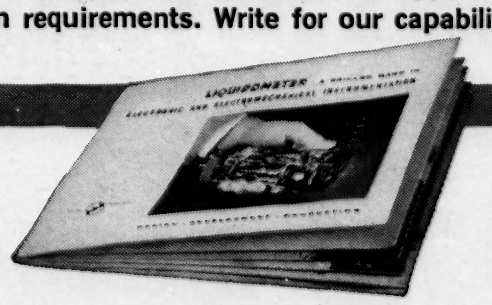
Another measure of the competence of Liquidometer in advanced instrumentation



FLUID, FOAM, OR FLOATING GLOBULES . . .

whatever a liquid's state or attitude, whether still or in agitation, the volume indication is the same with the Liquidometer Matrix Liquid Quantity Gauge. A capacitor type measuring probe — intercellular in construction — is the heart of the system. In addition to actuating an indicator, output can be telemetered, used for control purposes, or fed into computers. Potential applications: measuring liquid oxygen for astronauts; gauging liquids in advanced rocket propulsion systems; all-attitude gauging of aircraft fuels. Technical details in Booklet 694.

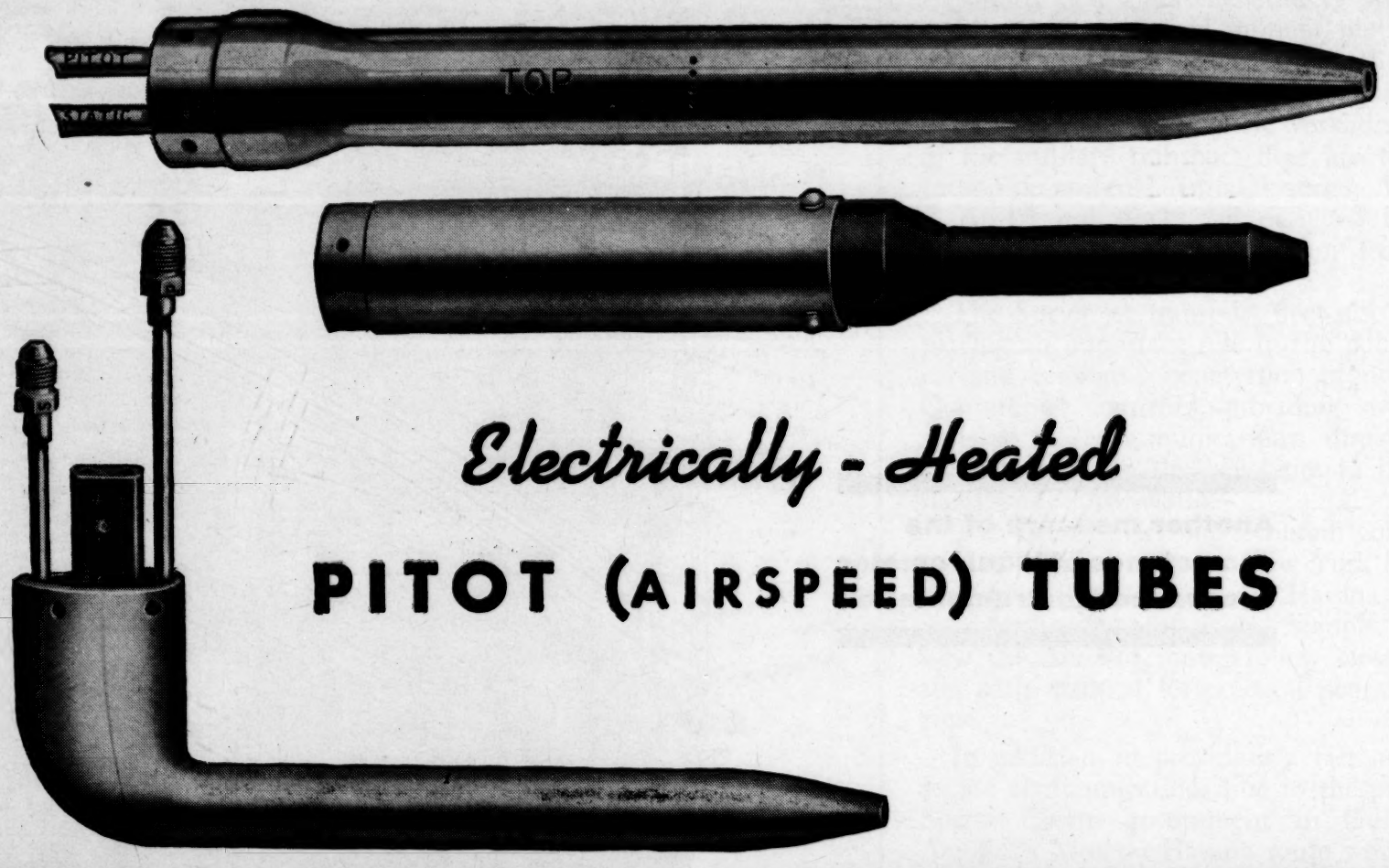
In the design and production of advanced instrumentation—electronic and electromechanical—Liquidometer offers many widely demonstrated capabilities, plus the talent and the willingness to pioneer. We welcome the opportunity to apply these qualifications, and our 40 years of experience, to your instrumentation requirements. Write for our capabilities brochure.



THE LIQUIDOMETER CORP.

DEPT. T2, LONG ISLAND CITY 1, NEW YORK

Since 1920 LIQUIDOMETER INSTRUMENTS --of proven quality



Electrically - Heated

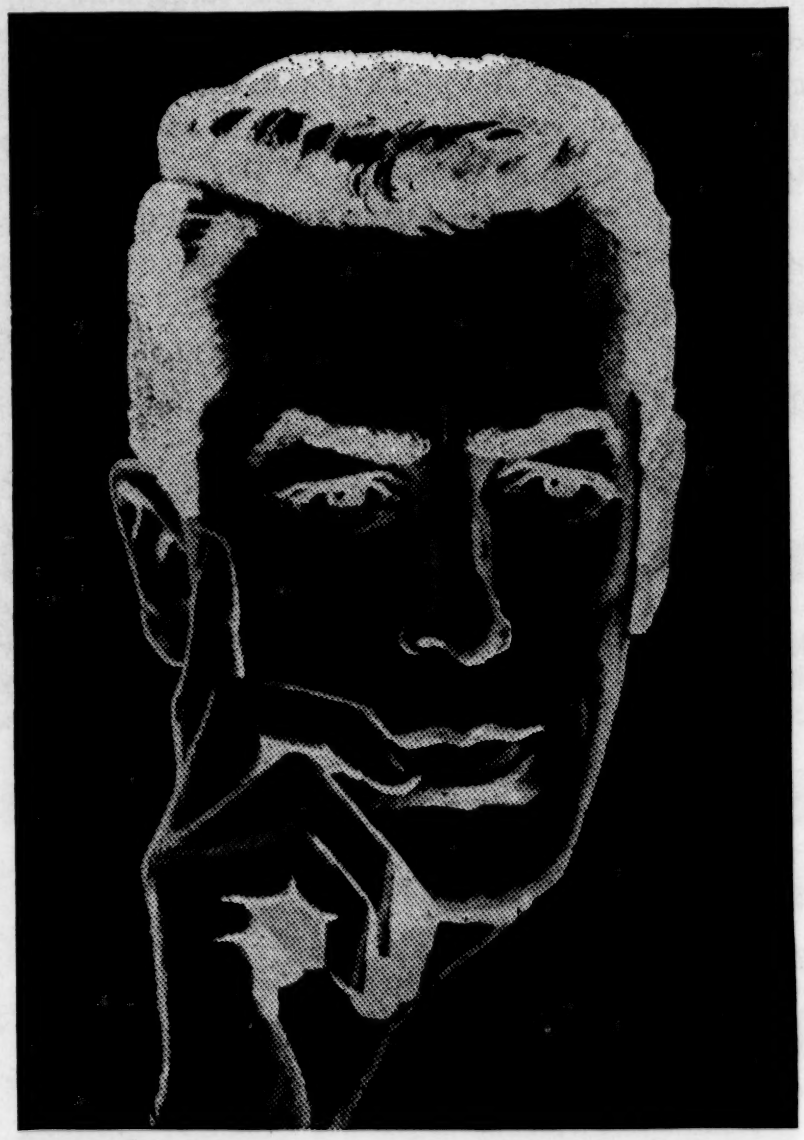
PITOT (AIRSPEED) TUBES

AERO INSTRUMENT CO.

5105 DENISON AVE. • CLEVELAND 2, OHIO

Manufacturers of Electrically - Heated Aircraft Parts Since 1925

Circle Number 288 on Reader-Service Card



a word to the engineer concerned about his future . . .

With Martin, the leader in missile/space technology, the engineer or scientist finds the keys which can open the door to a brighter professional future: Significant assignments in advanced programs . . . A creative engineering atmosphere that encourages a man's best efforts . . . A vital, fast-growing organization which assures exceptional advancement for the exceptional engineer.

We have immediate openings in our WEAPONS SYSTEMS and ELECTRONICS Divisions for ENGINEERS and SCIENTISTS experienced in a wide range of specialties.

Call or write Mr. D. C. Parsons, Professional Employment Manager, The Martin Company, Baltimore 3, Md. (MUrdock 7-3800, Ext. 8471).

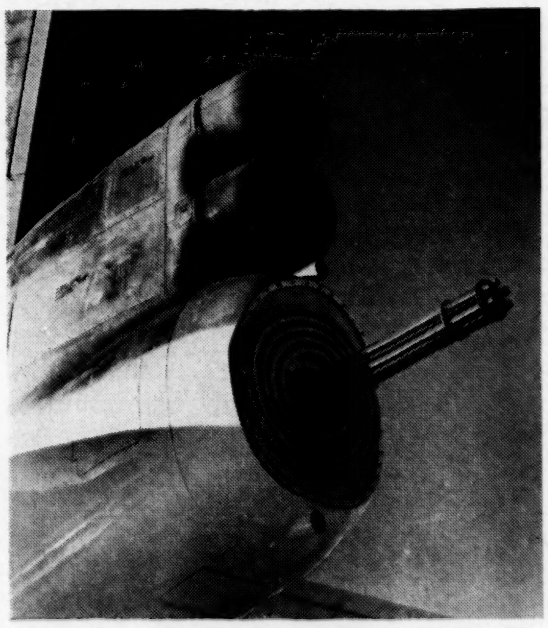
MARTIN
BALTIMORE

group in the 1,100-1,500 mi. range deployed against both European and Asiatic targets and with the 7,500-mi. ICBM aimed at the U.S.

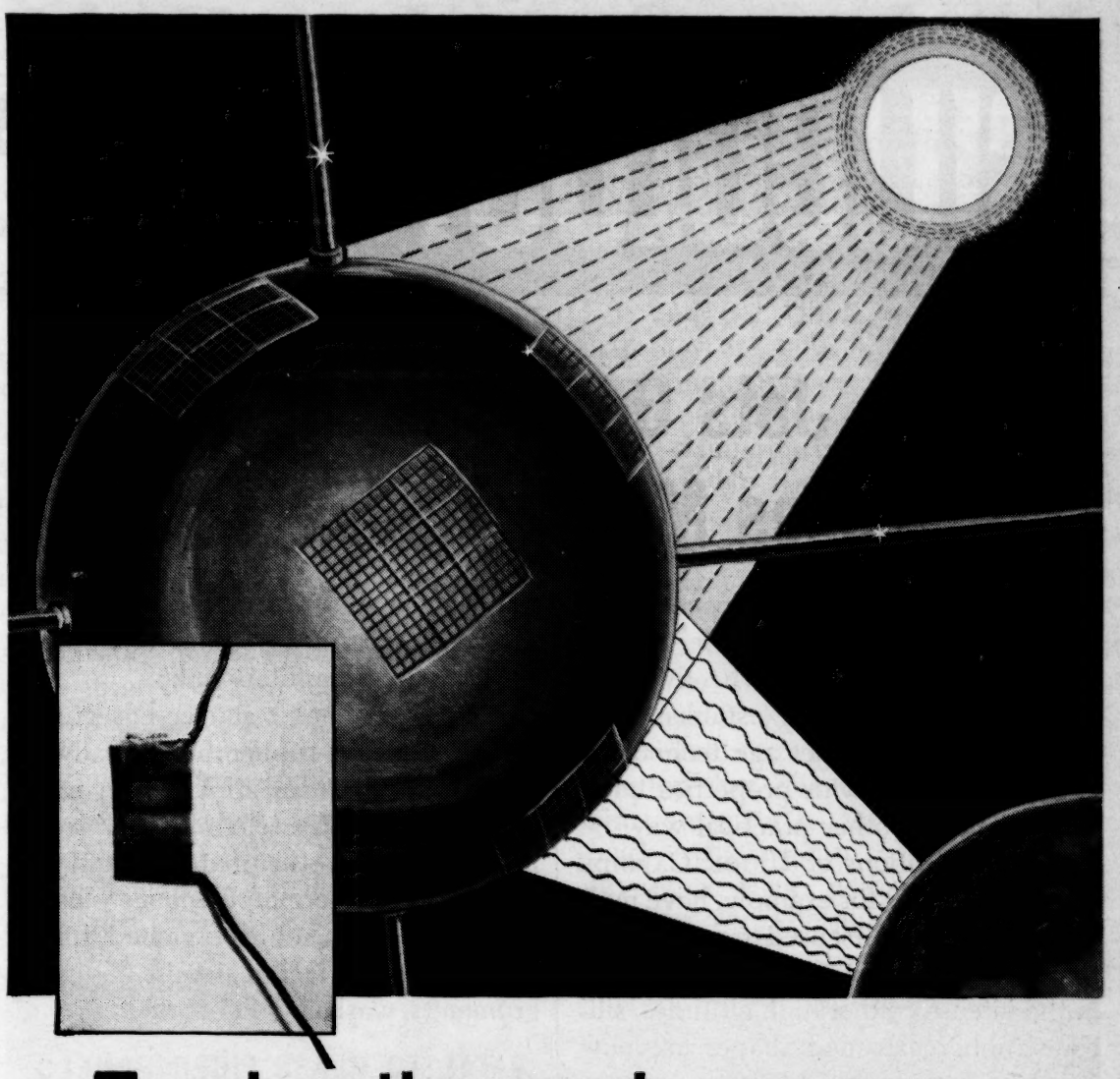
Soviet naval power is concentrated heavily on submarine forces, with nuclear-powered submarines now operating and a sizable force of conventionally-powered missile-launching submarines operational. These boats carry a complement of solid propellant ballistic missiles with an estimated range of 300 mi. for firing against shore targets.

Communist Chinese air force has been equipped with increasing quantities of MiG-19 supersonic twin-jet fighters and improved early-warning and ground control intercept type radars. Standard bomber is still the subsonic twin-jet Il-28. Heavy build-up of air strength continues in the coastal provinces opposite Formosa and the off-shore islands held by the Nationalist Chinese forces. A network of air bases with 12,000 ft. paved runways and large dispersal areas has been completed in these provinces, along with fuel pipelines to supply them. The Chinese Communist airline has been expanding its routes with Il-18 turboprop transports imported from Russia and has begun a small aircraft manufacturing complex of its own, mainly building small feederliners and transports that can use unimproved fields. The Chinese already have a large fleet of Il-14 twin-engine piston transports for both military and airline use.

In general, the outlook is for heavy Communist military pressure in Laos and Berlin, with political pressure heaviest in Iran in the Middle East and the new independent African nations. At the same time, a major Soviet diplomatic goal will continue to be maneuvering the U.S. into a position where its potent nuclear power, both strategic and tactical, will be outlawed by international agreement, opening the international chessboard to decisive moves with the Soviet Union's preponderance of conventionally armed masses.



GE B-52H TAIL STINGER



Taming the sun's energy to solar battery needs

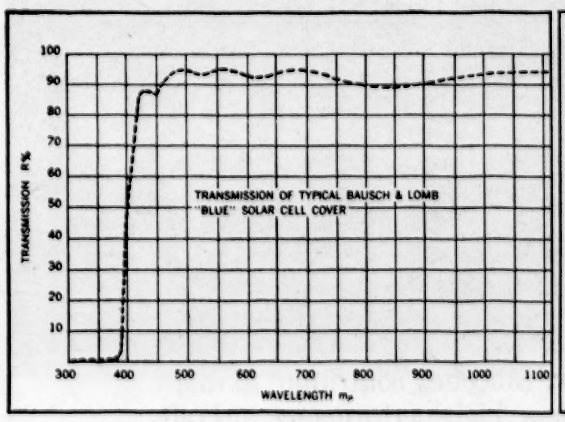
Bausch & Lomb optical/electronic/mechanical capabilities increase cell efficiency

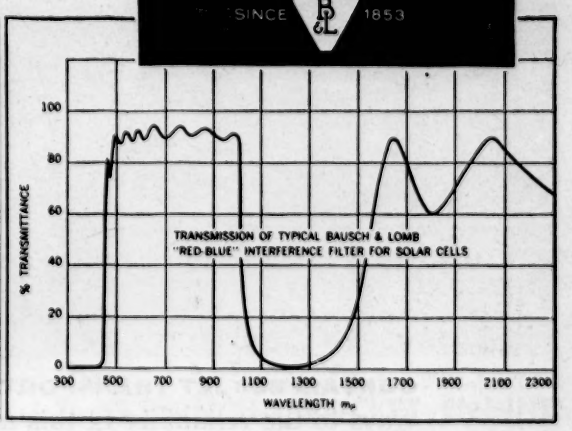
The only trouble with solar energy for satellite power supply is that there's too much of it. Only about 10% of the sun's radiation can be transformed into electrical energy. The remaining 90% just heats the solar cells, reducing their efficiency.

Bausch & Lomb coatings enhance the efficiency of solar cells by allowing them to operate at cooler temperatures. "Blue" (see typical curve) coatings—selectively absorb the radiation needed to energize the cells. The "Red-blue" coatings bounce the hot infra-red radiation back into space (see typical "red-blue" curve).

Find out how B&L capabilities can help out on *your* next project—in design, development and production. Ask for our technical reports: Bausch & Lomb Incorporated, Military Products Division 82115 Bausch Street, Rochester 2, N. Y.

BAUSCH & LOMB
SINCE B&L 1853





Circle Number 103 on Reader-Service Card

SILICOLOGY

Studies in Silicones

HOW THESE TIME-TESTED MATERIALS CAN WORK FOR YOU

As the Jets Go Faster, Hotter... Silicones Match Their Needs

Just a few years ago, silicones were "wonder chemicals of the future." Today, their future is here. In the aviation industry they are firmly established as reliable materials of jet age technology and engineering, with properties unattainable in any other practical way.

The applications of UNION CARBIDE Silicone Rubber, for example, have multiplied steadily. First used to make bomb bay door seals that would stay flexible in the intense cold of high altitudes, silicone rubber extruded shapes are now standard equipment on both military and commercial jets where lasting reliability is a basic requirement.

FROM RADIOS TO OXYGEN MASKS

Sensitive aircraft radar, radio, and other electronic equipment is designed today with much of its wiring insulated with silicone rubber. Flexible from far below zero to several hundred degrees F., it is resistant to ozone, light, and chemicals, and has excellent electrical properties.

Soft, lightweight, flexible silicone rubber oxygen masks for both passengers and crew are now regular equipment for airlines and military alike.

Jet engine hot-air starter hoses containing silicone rubber are equally at home in the arctic or tropics. They resist searing heat with a reliability that is unmatched by any other material. And silicone rubber's thermal resistance plus its low compression set have gained, for it, widespread aviation use in O-rings, grommets, washers and boots.

VITAL TO GLASS FIBER PANELS

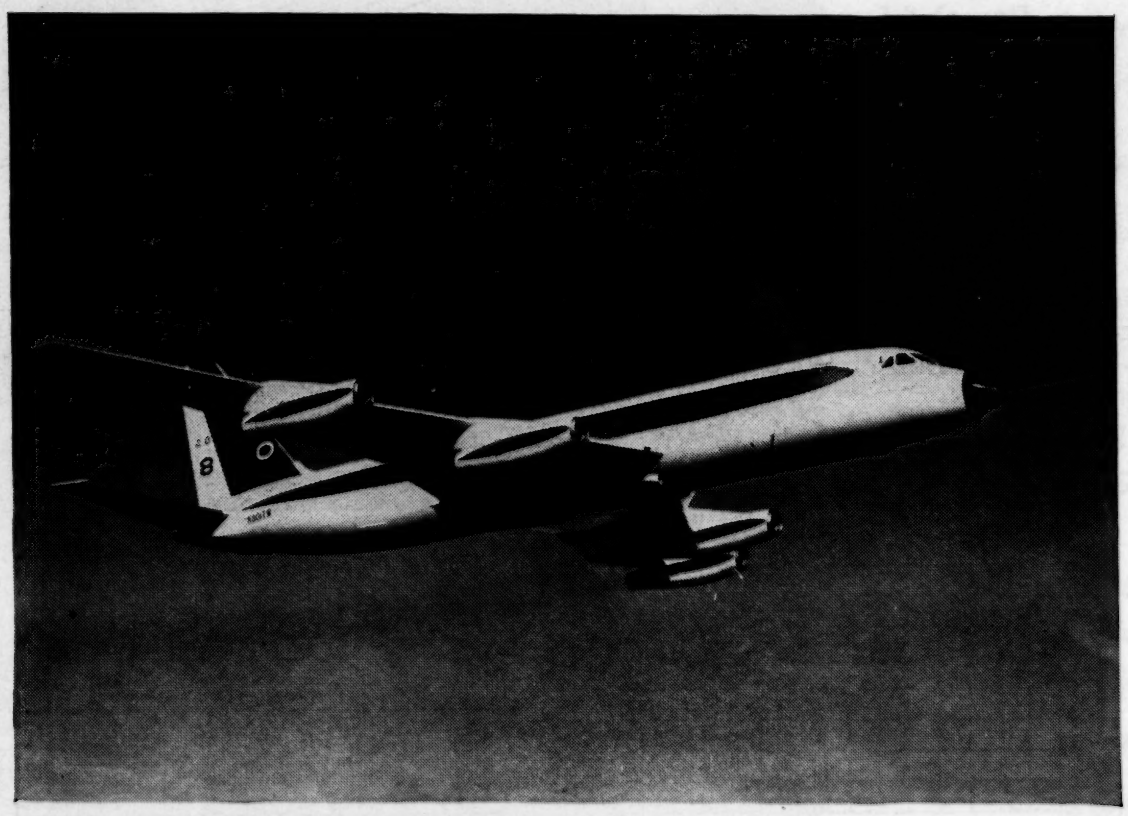
There are more and more places in modern jets where light, tough, glass-fiber-reinforced plastic panels and shapes serve yeoman duty. In cabin walls, partitions, radomes, tail-cones, instrument panels, fairings, to name a few. In many of these, a UNION CARBIDE silane plays a strong role. Applied to the fibers, it unites them chemically with the plastic. Thus it keeps moisture from penetrating between these vastly unlike materials, preserving panel strength and extending its working life spectacularly.

And today UNION CARBIDE Silicone Resins are in growing demand for high-temperature paint systems to insure maintenance of smooth protective surfaces on the wings and bodies of supersonic jets.

Among the varied uses of UNION CARBIDE Silicone Fluids there is one that ranks them in importance with rubbers and resins. For without this all-temperature, constant-viscosity damping fluid in instrument needle-shaft bearings, these delicate devices would be far less reliable . . . and safe. Another very important factor is that silicone fluid's extremely high compressibility allows damping devices to be of smaller size.

RE-APPRAISE YOUR OWN NEEDS

In the aircraft industry, especially, technology and development are changing more rapidly than ever before. Perhaps you are overlooking a good bet—some place in the design of your products where silicones can serve you, improving quality at surprisingly low cost. Send the coupon for further information.



CONVAIR 880 JET TRANSPORT. Silicones contribute in many ways to the reliability of this new high-performance aircraft.

UNION CARBIDE

SILICONES

UNION CARBIDE is a registered trade mark of Union Carbide Corporation.

Silicones Division
Union Carbide Corporation
Dept. DA-0101,
270 Park Avenue, New York 17, N. Y.

In Canada: **Union Carbide Canada Ltd., Bakelite Division, Toronto 12.**

Please send me data on _____

_____

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ **ZONE** ___ **STATE** _____

Circle Number 104 on Reader-Service Card

Russia Still Holds Four-Year Space Lead

By Evert Clark

Soviet Russia has entered a new phase of space exploration in a better position than ever to make military, scientific and psychological capital of her lead over the U.S.

In spite of great effort and some noteworthy achievements by U.S. military and civilian space teams, Russia still enjoys the same four-year lead in rocket propulsive power with which it began the space age—a lead that has been conceded but too often has been downgraded in importance by U.S. leaders.

It is this very rocket power that offers Russia an excellent chance to place the U.S. in secondary military and scientific positions just as she has made this nation second in the prestige race over space.

It was a fear of Soviet military and prestige advantages that caused the U.S. to enter the space race in the first place—yet many influential U.S. scientists still argue against basing any space effort on an attempt to regain lost prestige.

U. S. Debate

While Russia forges ahead on a timetable that is her own, the U.S.—three and a half years after Sputnik I—again is reviewing both its civilian and military efforts, with a knowledge that neither is adequate, but with a suprising lack of agreement on what should be done to improve either one.

President Eisenhower left office less than two months ago with a cautionary note to Congress in his budget message to the effect that even manned space flight was still a doubtful undertaking in his mind.

"Further testing and experimentation will be necessary," the outgoing President said, "to establish whether there are any valid scientific reasons for extending manned space flight beyond the Mercury program."

This view was shared to a great degree by Eisenhower's last science adviser, Dr. George T. Kistiakowsky, and is held to a lesser degree by President Kennedy's new science adviser, Dr. Jerome B. Wiesner. Meanwhile, Soviet scientists express only determination to overcome the barriers to manned space flight, rather than doubt its worth.

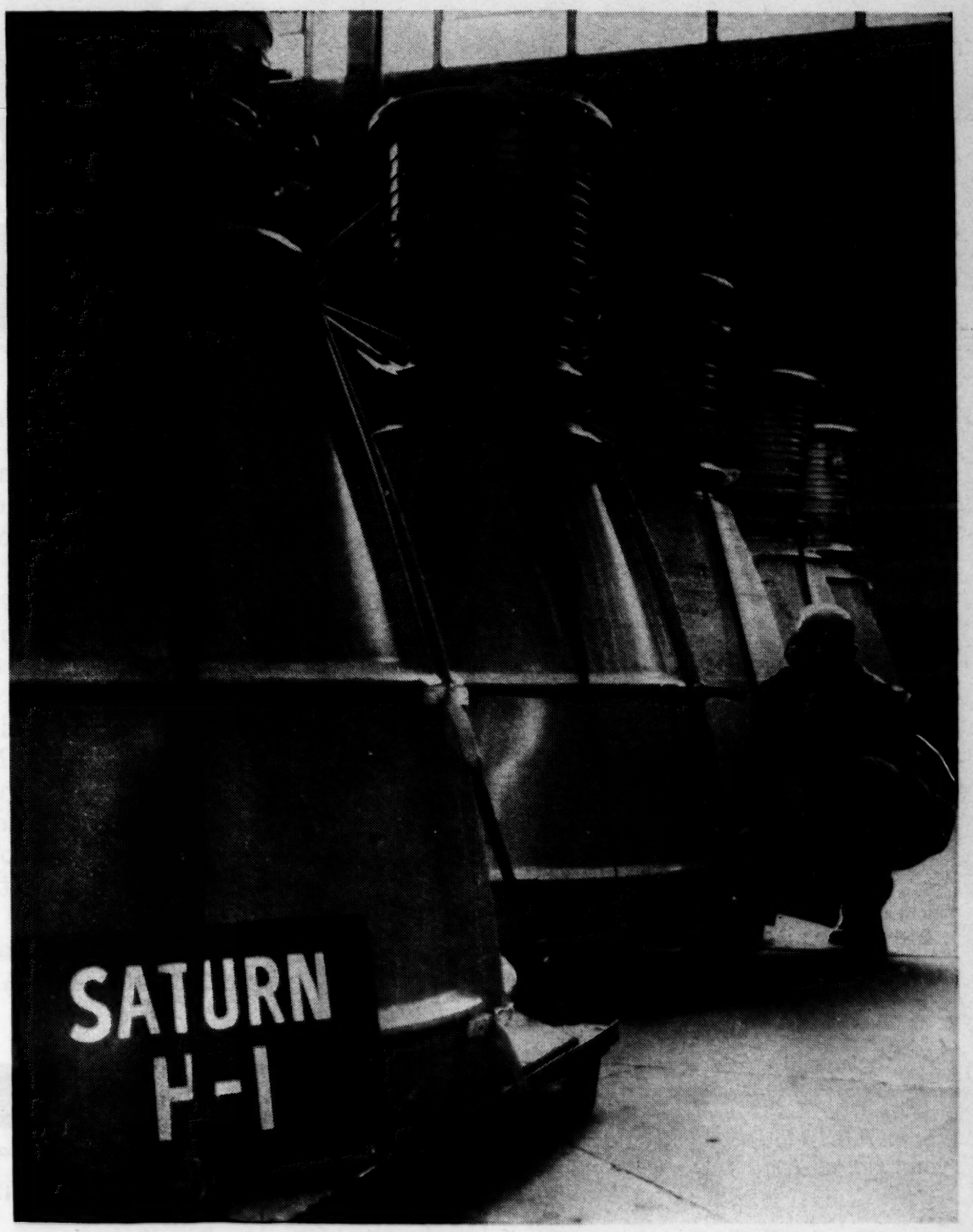
Russia's ability to place seven tons of payload into an earth orbit and to use a satellite as a space platform for interplanetary rocket launchings has again fanned the coals of controversy over what kind of lead the Soviet Union has and of what significance that lead is.

Those who attempt to depict the U.S. position in the most favorable light agree that Russia leads in rocket propulsion but say that lead will soon be overcome, or that it doesn't matter anyway because the U.S. leads Russia in the space sciences.

Military benefits that accrue to a nation able to lift seven tons of hardware into orbit are ignored or are mentioned only as they affect missile applications. Then it is possible to say, as Sen. Richard Russell (D.-Ga.), chairman of the Senate Armed Services Committee, did late in February, that it matters little whether a man is killed by the many tons of explosive that a Russian missile could deliver or the few tons that a U.S. missile could deliver.

Dr. Kistiakowsky said a year ago, when he was the President's science adviser and the relative positions of the U.S. and the USSR were essentially what they are now, that Soviet scientists, although they had made "important discoveries in outer space, cannot claim supremacy in outer space sciences." He also divorced exploration of space from military considerations.

"If one separates civilian space science and technology from military missiles, which is entirely feasible, one wonders whether our insistence on superiority in space is of overriding importance," Kistiakowsky said. "The unfortunate aspect is that space exploration has caught the public imagination to the extent that it gives the Soviet achievements somewhat more importance than, perhaps, they rightfully deserve. The public reaction both



SATURN H-1 ROCKET ENGINES

COMPARE

THIS HIGH-SPEED, LOW-COST SWITCH

WITH ANY OTHER

Philco's Improved 2N1499A MADT

ABSOLUTE MAXIMUM RATINGS

Storage Temperature	−65 to +100°C
Collector Voltage, V_{CB}	−20 volts
✓Collector Voltage, V_{CES}	−20 volts
✓Collector Current, I_C	−100 ma
Total Device Dissipation at 25°C	60 mw

ELECTRICAL CHARACTERISTICS (T = 25°C)

Static Characteristics	Min.	Typ.	Max.	
Collector Cutoff Current, I_{CBO} (V_{CB} = −5v)		1	3	μa
✓ Collector Cutoff Current, I_{CBO} (V_{CB} = −5v, T = 55°C)			18	μa
✓ Collector Breakdown Voltage, BV_{CBO} (I_C = −25 μa)	20			volts
✓ Collector Breakdown Voltage, BV_{CES} (I_{CES} = −25 μa)	20			volts
DC Current Amplification Factor, h_{FE} (V_{CE} = −0.5v, I_C = −40 ma)	20	50		
✓ DC Current Amplification Factor, h_{FE} (V_{CE} = −0.3v, I_C = −10 ma)	30	70		
Base Input Voltage, V_{BE} (I_C = −10 ma, I_B = −1 ma)	0.25	0.32	0.40	volt
Collector Saturation Voltage, V_{CE} (SAT) (I_C = −10 ma, I_B = −1 ma)		0.12	0.20	volt
Collector Saturation Voltage, V_{CE} (SAT) (I_C = −10 ma, I_B = −0.5 ma)		0.15	0.25	volt
✓ Base Input Voltage, V_{BE} (I_C = −10 ma, I_B = −0.5 ma)			0.34	volt
Dynamic Characteristics				
Output Capacitance, C_{ob} (V_{CB} = −6v)		1.5	3	pf
Rise Time, t_r (V_{CC} = −5v, I_C = −10 ma, I_{B1} = −2 ma)		25	60	nsec
Minority Carrier Storage Time Constant, τ_s (K's)I_B = −1 ma		100	120	pcb/ma
✓ Gain Bandwidth Product, f_T (V_{CE} = −3v, I_C = −5 ma)	100			mc

✓ Checks indicate specification improvements

Immediately available in quantities 1-999 from your Philco Industrial Semiconductor Distributor

Now with New, Tighter "Specs"

In high-speed switching circuits, this Philco MADT has a long record of reliable performance. It has always been manufactured to meet rigid specifications . . . not selected as a fall-out device.

Now . . . the 2N1499A is being produced to still tighter specifications, making it far more versatile and permitting greater freedom in circuit design.

New high current rating makes it suitable for line drivers, blocking oscillators, etc. Higher amplification factor (h_{FE}), makes NOR circuit design much easier. V_{BE} and V (SAT), guaranteed at 2 drive conditions, give tight control for all saturated circuit designs.

For logic circuits operating at rates up to 10 mc, it will pay you to get the facts on the improved Philco 2N1499A. Compare it . . . you'll find it impossible to beat in performance, reliability, versatility and price. Write Dept. AW31361.

PHILCO®

Famous for Quality the World Over

LANSDALE DIVISION, LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.

See us at IRE—Booths 1302-1308

Circle Number 108 on Reader-Service Card

here and abroad has been fostered assiduously—and not unnaturally—by the Soviet propaganda machine and in a sense, by some of our own space enthusiasts."

Kistiakowsky was attempting to make the valid point that it is essential to differentiate between science and technology. President Kennedy has made the same distinction in recognizing the Soviet lead in booster capability while claiming a U.S. lead in the space sciences.

Unfortunately, this differentiation has become almost an excuse—and if it is true that the U.S. leads in scientific exploitation of the satellite and space probe, how long can it remain true when Russia so obviously has the superior tools with which to make scientific explorations?

Campaign 'Gap'

Use of this differentiation between science and technology to make the U.S. position appear better than it might be reached an apogee of sorts last October when Vice President Richard Nixon said that the Eisenhower Administration had "just about closed an inherited space gap. We have been hard at work on the related problem—the so-called missile gap—likewise inherited—and we have achieved great success.

"With expenditures of more than a billion a year, utilizing the great resourcefulness of the giant industrial complex of America as well as that of the federal government, we have surpassed the Soviet lead in the space competition in all respects but that of rocket thrust, where the failures of the last Administration handed the Soviets a several-year lead; and even that lead is soon to be surpassed."

Testimony by Dr. Hugh L. Dryden, who served as the top technical man in the civilian space agency under both Eisenhower and Kennedy, is that the U.S. will not have the thrust to duplicate Russia's Sputnik VIII Venus probe experiment until 1965 or later, unless some real breakthrough occurs.

Thus the argument that Russia leads "only" in propulsive power overlooks the fact that this lead now is the same in time as it was when the race began. It overlooks military applications of space technology—even though the U.S. is engaged in applying space to military missions now—and it assumes that the U.S. now leads and will continue to lead the Soviets in scientific gain.

There is growing concern in the U.S. that Russia may at any convenient time drop its pretense that is interested only in the peaceful uses of space and begin to practice a satellite blackmail similar to the missile blackmail that it has used in diplomatic circles since 1957.

Russia obviously has some need for reconnaissance-geodetic satellites, weather and navigation satellites for both military and civil use, and—in the Russian view, at any rate—a need for early warning satellites similar to the Air Force Midas. It has already demonstrated by recovering life from orbit and sending a rocket from an orbiting satellite toward the planet Venus that it has the engineering capability to send bombs down from orbit if technically and politically desirable.

Its booster and satellite capability also raises the strong possibility that Russia will explore boost glide aircraft, which have considerable potential in both the military and civilian spheres.

To find solace in a distinction between pure scientific gains in space and the wherewithal to accomplish these explorations again ignores the basic problem. T. Keith Glennan, former head of the civilian space agency, said a year ago that 85% of his agency's work was aimed not at the mysteries of science but at solution of engineering problems involved in design, construction and operation of launch vehicles, payload and tracking stations, and in acquisition and reduction of data. That situation has not changed.

Leadership Image

The image of world leadership in space that Russia has been building may or may not carry over into an impression that Russia leads the world in other fields.

Dr. James R. Killian, Jr., who came into the White House as the first presidential science adviser shortly after Sputnik I forced the United States to begin building a real space program, said last December:

"I believe that in space exploration as in all other fields that we choose to go into, we must never be content to be second best, but I do not believe that this requires us to engage in a prestige race with the Soviets.

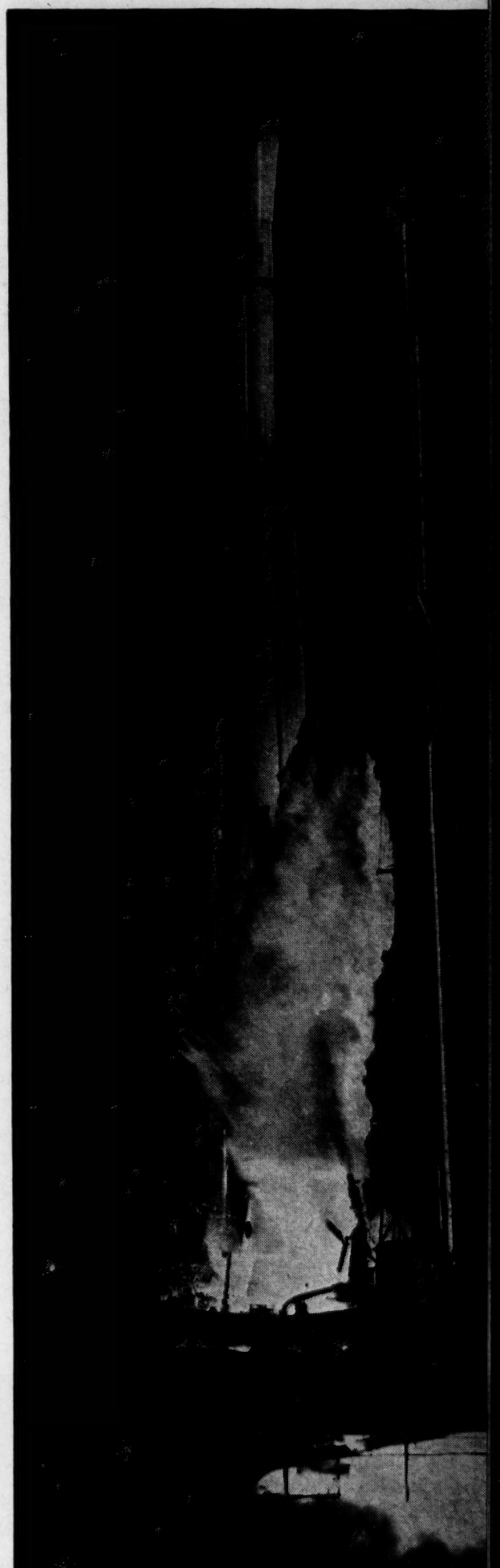
"We should pursue our own objectives in space science and not let the Soviets choose them for us by copying what they do." The Russians, Killian said, have "sought constantly to present spectacular accomplishments in space technology as an index of national strength and too often the press and the public at large have interpreted these spectacular exploits as indices of strength."

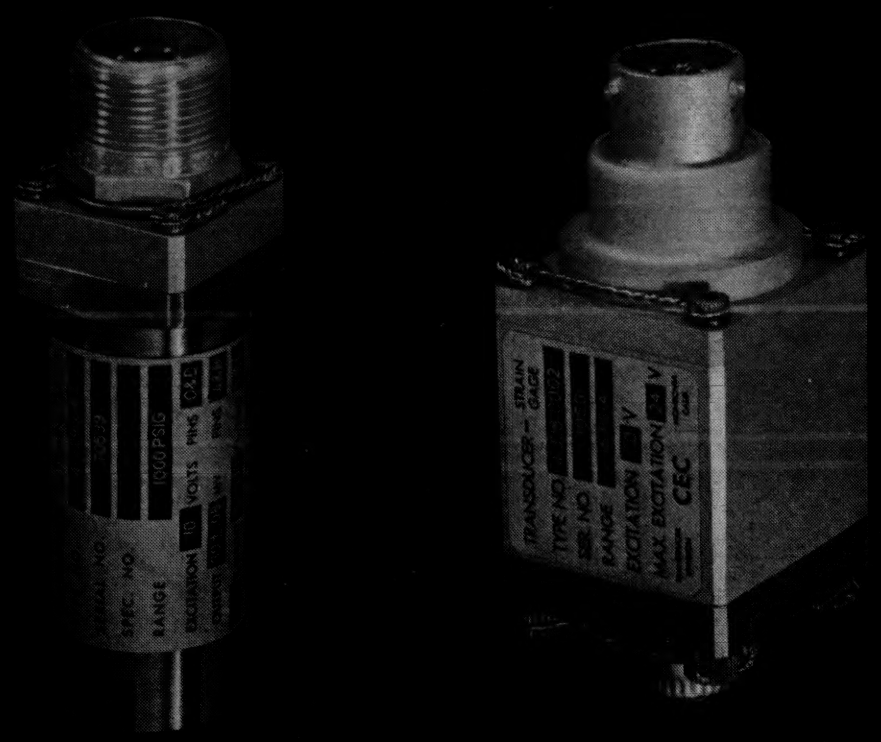
Dr. Killian's view is shared by many within and outside the U.S. space program, if not by the Russians. It is in great contrast to the conclusion reached six years ago by Dr. Clifford C. Furnas, chancellor of the University of Buffalo, and eight others who were asked to advise the assistant secretary of defense for research and development as to whether the United States should undertake a space satellite program.

Dr. Furnas related last November how, in the spring of 1955, the nine advisers were asked to consider a technical intelligence report that had been presented to the National Security Council "indicating that the Soviet Union was working assiduously on a satellite project, and that there was a high probability that Russia would achieve success in the not distant future.

"It was anticipated that such a technological feat would be militarily im-

TIROS II LAUNCHING





High range . . . low range–

BOTH OF THESE NEW CEC PRESSURE TRANSDUCERS FEATURE BUILT-IN SHUNT COMPENSATION

These new strain gage units are the most accurate and highly sophisticated pressure transducers ever built for rugged airborne use. They were designed to outperform every known similar type of instrument . . . and they do.

Their shunt calibration feature permits the system designer to provide—quickly and simply—a complete calibration of his data handling system for precise control of associated equipment.

Type 4-328 (square) is a low-range unit for pressure ranges of 0-15 psi through 0-99 psi absolute. Standard ranges are 0-15, 20, 30, 50 and 75 psi absolute. **Type 4-329** (tubular) is a high-range unit for pressure ranges of 0-100 psi through 0-5000 psi absolute. Standard ranges are 0-100, 150, 250, 500, 1000, 1500, 2500 and 5000 psi absolute.

Here are some of the specifications they have in common:

Rated electrical excitation: 20v dc or ac rms; carrier frequency 0-20 kc.

Sensitivity: 50 mv ±0.25 mv into a 50k load at rated excitation and 77° F.

Compensated temperature range: +30° F. to +250° F.

Weight: 5.5 oz. max. exclusive of mating electrical connector.

Input Impedance: 700 ohms minimum.

Output impedance: 350 ohms ±10% at 77° F.

Shunt output: 33,270 ohms keyed across negative input and negative output pins at zero applied pressure, rated excitation, and 77° F., produces an electrical output change equal to the sensitivity within a tolerance of ±0.355%.

For more information and complete specifications, call your nearest CEC sales and service office or write for Bulletin CEC 4328-X3 or 4329-X3.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell · FINER PRODUCTS THROUGH IMAGINATION

portant and have great propaganda and prestige value. Hence, the U. S. should give very serious consideration to a program pointed toward the successful launching of the first satellite before the Russians could steal a march."

Furnas said the group met several times and considered all scientific and engineering angles. "It was felt that such a project on the part of the U. S. at that time would be a bit premature," he said. "Five years later would have been a more feasible time for proceeding in an orderly fashion.

"However, in view of the international situation, it was decided that the project should go forward even though technical success at that early period was by no means assured. The decision was unanimous. Thus, it was international politics which was the decisive factor in what at first glance was an engineering matter."

Furnas and two others dissented from the decision to initiate development of the Vanguard launching vehicle, favoring instead use of the Army Redstone because of its quicker availability, but the accuracy of the group's estimate of the psychological importance of Russia's plans was borne out many fold.

Studies of foreign public opinion, made by the U. S. last year and debated in the last presidential campaign, were released to the public after the change of administrations in January.

They reflect a belief that the "clear preponderance" of over-all national power which was attributed to the U. S. before Sputnik I has given way to a feeling that "the USSR now enjoys a rough but effective equivalence in strength overall" and that the trend is adverse to the U. S. The surveys also concluded:

"The enduring prevalent image of a substantial Soviet advantage in space . . . appears to rest on a strong belief that the USSR has got there 'fustest with the mostest,' and 'most' is apparently based on a more complex calculation than simple enumeration. Number apparently has not captured the public imagination as mass, range and primacy seem to have done."

The tendency in the U. S. to assume a supposed scientific superiority as the life-saving reed when the question of relative positions in space is debated may also prove in the next few years to have been more of an assumption than a hard fact.

Although published results of space exploration appear to give the U. S. a comfortable edge, these points must be considered:

• **U. S. does not really know** what Russia has learned from her satellite and space probe experiments. Although Russia could gain considerable propaganda advantage by publishing all scientific findings fully and immedi-

← Circle Number 110 on Reader-Service Card

ately, there has been no strong indication that she felt a need to do this. Soviet scientists, by virtue of the fact that they have launched laboratories of impressive weights, enjoy a certain status in the international scientific community. These attempts to learn, coupled with the knowledge gained that has been reported, are recognized in such substantial ways as election of Russians to the presidencies of at least three international scientific bodies. At least a few instances in which the Russians have learned more than they have revealed are known. A report prepared by U. S. intelligence sources for the Commerce Department noted that Sputnik III had discovered a new type of corpuscular radiation about which no details had been released.

• **Effects of radiation** and weightlessness on man—possibly the most important question about space flight for many years to come—could be learned first by Russia which has the potential to find the answer long before the U. S. does. This does not guarantee that Russia will answer this or any other question first, but her scientists are approximately as capable as those of the United States at interpreting findings, and she has much more chance to make them.

The Commerce Department survey notes that the U. S. leads in significant, over-all cosmic ray research but says that Russia probably has an edge in establishing the effects of radiation on humans because of her long lead time in rocket research and satellite research with animals. There also is a likelihood that she will precede the U. S. into manned flight itself.

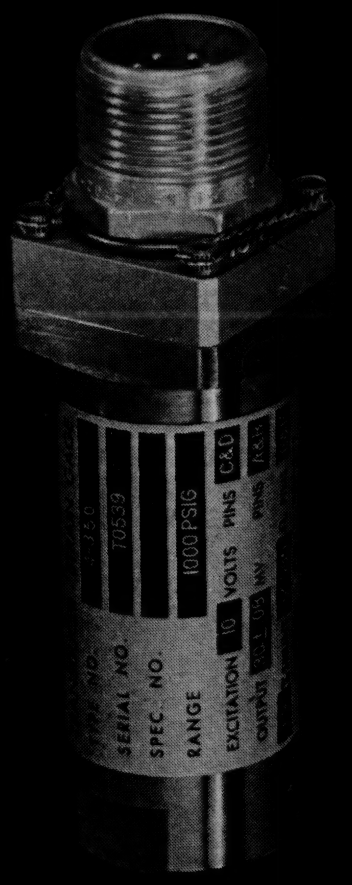
Russia suffers from the use of obsolete equipment and relatively primitive research methods in some areas of cosmic ray research, just as she does in some other scientific fields. But the Soviet bioastronautics program, based on sounding rockets up to a size that can carry a manned capsule, has been uninterrupted since 1947.

In Sputnik II, Russia put the first living organism into orbit. In Sputnik V, the second of the so-called "spacecraft," she orbited and recovered two dogs, 42 rats and mice, fruit flies, fungi, chlorella, seeds of corn and wheat, peas and onions, and a number of lesser forms of organic life. The satellite also carried blocks of photo emulsions. Some of these were developed on board and the data telemetered, and some were recovered.

With the newer seven-ton sputniks, Russia's scientists have a remarkable tool at their disposal that will handle almost all of the many missions projected by her scientists during several years of spaceflight discussions.

More and more, the statements of

Circle Number 111 on Reader-Service Card →



THIS RUGGED TRANSDUCER ASSURES OVER-PRESSURE PROTECTION DURING GROUND TESTING

Here is the new high precision, corrosion-resistant instrument that rounds out CEC's line of strain gage transducers to provide coverage from ground through airborne testing.

This highly accurate, highly sensitive transducer is the 4-350, designed for ground testing... ground support equipment for missile launch and test facilities ...and for industrial process instrumentation.

Its airborne counterparts are Consolidated's 4-328 and 4-329. Because all three have an output of the same integrity, it is now possible to use the new 4-350 on the ground and the two lighter weight units in the air without data "changing."

You'll find that all three transducers have the same general sensitivity and that most of their specifications are the same. Features of the 4-350 emphasize the protective characteristics necessary in ground developmental activities, where test parameter limits may not yet be fully established.

For more information, call your nearest CEC sales and service office or write for Bulletin CEC 4350-X2.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell • FINER PRODUCTS THROUGH IMAGINATION

for research and development... the most versatile, portable 16mm motion picture camera!

ARRIFLEX® 16

For documentation, instrumentation, film reports, public relations, for every industrial and scientific application... no other camera does them all as well as ARRIFLEX!

World-famous mirror-shutter reflex system • Precision registration movement • Electric motor drive • Divergent turret •

Many other unique features that make professional filming a simple procedure for the research engineer and scientist.

SEND COUPON TODAY!

ARRIFLEX CORPORATION OF AMERICA
257 PARK AVENUE SOUTH, NEW YORK 10, N. Y.

Without obligation, I would like:
☐ DEMONSTRATION ☐ LITERATURE
☐ on ARRIFLEX 16 ☐ on ARRIFLEX 35

name_____
company_____
address_____
city zone state s

Circle Number 112 on Reader-Service Card

responsible Soviet scientists have come to be recognized as previews of what is soon to be done, rather than empty predictions dispensed for propaganda value alone. Some examples:

• **In January of 1960,** just after Russia had announced that she would test new rockets in an area of the Pacific Ocean, Soviet scientists said the rockets would be used for satellites of the moon, cosmic rockets with orbits "more or less close to that of Mars or Venus," and "earth satellites that are returned to earth and retrieved." Two of the three possibilities have become realities.

There is some indication that a Mars shot also was planned but did not materialize, and there was still another prediction of the Venus shot. Prof. A. A. Blagonravov said early last year: "It is obvious that everything is being done so that such a ballistic flight (to Mars) will be possible at the end of 1960, at a time when Mars will be at a relatively close distance to earth. It will be in 1961 that Venus can be approached with the greatest chance of success."

• **After the January 1960 tests,** Prof. Vladimir V. Dobranravov said the "complete rocket" that would be launched when all tests were finished would be "a vehicle whose goal is to transform itself into a lunar satellite or to reach other planets." The reference to transformation apparently meant the launch-from-orbit technique used with Sputnik VIII. Other Russian scientists wrote during this period that the new rocket made possible satellites that would weigh several tons and serve eventually as "transit stations" for manned flights to the moon and planets. Although Sputnik VIII's probe to Venus was unmanned, this again was an apparent reference to the space platform technique. AVIATION WEEK reported at that time (Feb. 15, 1960, p. 31) that, "recent Soviet references to these large earth-orbiting satellites make them sound as if they might be launching bases for interplanetary rockets rather than merely necessary experimental steps that must precede launching of manned rockets directly from earth." Prof. Y. Pobedonotsev of the USSR Academy of Science space commission said about the same time that a space platform had to be established "for launching rockets to other planets."

• **Shortly after the launching** and unsuccessful attempt to recover Sputnik IV in May of last year, Scientist V. Parin wrote in Izvestia that an essential for the future would be "continuous and thorough surveillance of all functions of animals coming back to earth after a long stay on artificial satellites." His observation was followed in late August by the launching of Sputnik V and the recovery of its menagerie.

Russia has appeared to follow a phased program—three earth satellites in late 1957 and early 1958, aimed at proving the feasibility of satellites and studying the space environment around earth; three lunar vehicles, all in 1959; the first three five-ton "spacecraft" in 1960, all apparently aimed at determining the hazards of and ways of supporting life in orbit as well as at proving the vehicle; and the new seven-ton "space platforms."

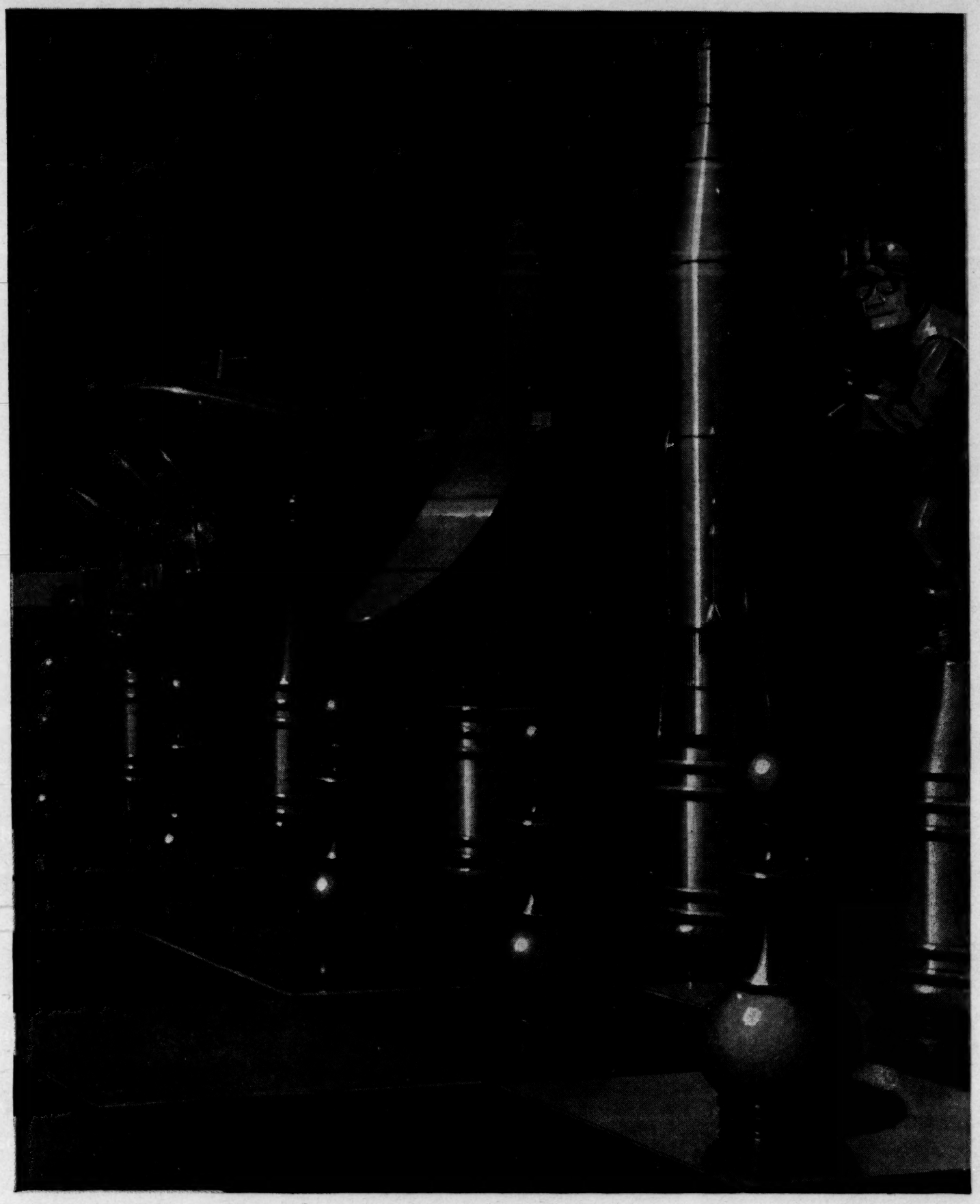
It is impossible to find any evidence that Russia intends to stand still and let the U. S. catch up in booster power, and it is not easy to see that the U. S. is likely to hold a scientific superiority when Russia apparently has developed at least two types of large general-purpose space vehicles with which to broaden her exploratory ventures.

The Venus probe is expected to come within 100,000 mi. of the planet. Russian scientists have talked often of establishing observation stations on the moon and planets and of returning samples of materials—and life, if it exists—from these natural bodies. Laboratories that can crawl over the surface of another planet have been proposed and probably are being built. Spacecraft in the two- to four-ton weight class, that would carry men on two- or three-year flights, have been mentioned frequently by Soviet scientists. Although this is undoubtedly further away than most experiments, Russia leaves the impression that it is something she intends to do—eventually, if not in the near future.

So far Russia has said much but apparently done little to apply the benefits of space research in practical ways—weather forecasting, for example. It may be that such application is planned but not discussed publicly, or that exploration is occupying all the available resources.

Soviet scientists have rejected the idea, shared apparently by totalitarian states and democracies, that the great cost of space exploration might delay development of other segments of the economy. Dobranravov, no doubt acting as a spokesman for the government which backed the vast Soviet space program, said that cosmic research would pay large, tangible dividends in weather forecasting, radio and television, application of atomic energy, and advancement of automation, instrument design, radio electronics, biology and medicine. He also said the "enormous political and international significance" must not be overlooked.

Russia is pursuing these advantages, and there is always a possibility that the gap will widen—if not in a scientific or practical or military way, then in the area of man's imagination.



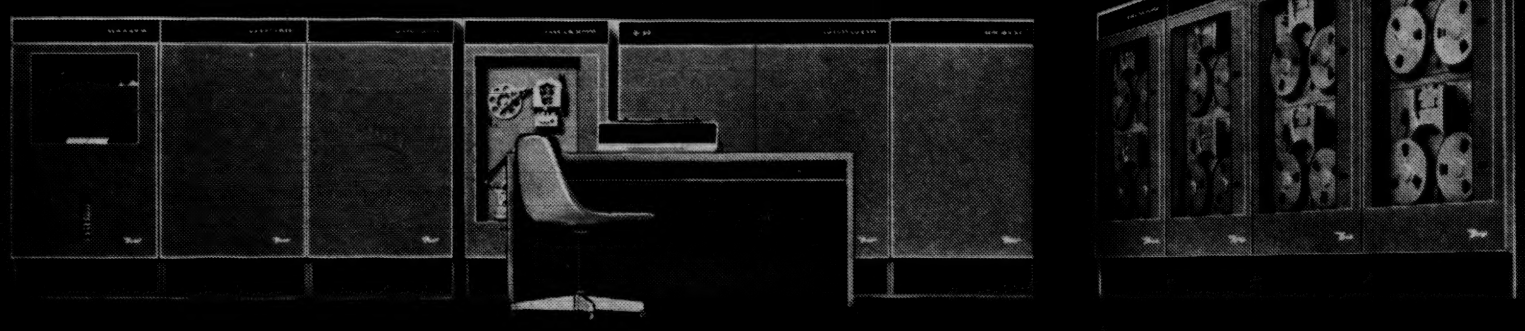
Strategy of peace through strength. Each of our armed forces is assigned a different defense job. The Pentomic Army . . . the nuclear Navy . . . the strategic and tactical Air Force. Each must be equipped to support the strategies of peace. Avco scientists, engineers, and skilled production personnel from these divisions are helping produce many kinds of military material needed for a balanced defense: Avco-Everett Research Laboratory—investigating problems in gas dynamics and space technology; Electronics and Ordnance Division—communications, radar, infrared, electronic control systems, missile fuzing, classified ordnance; Lycoming—aircraft, marine and industrial power plants, missile subsystems; Nashville—aircraft and missile aluminum and stainless steel structures; Research and Advanced Development Division—basic and applied research in electronics, physical sciences, and engineering.

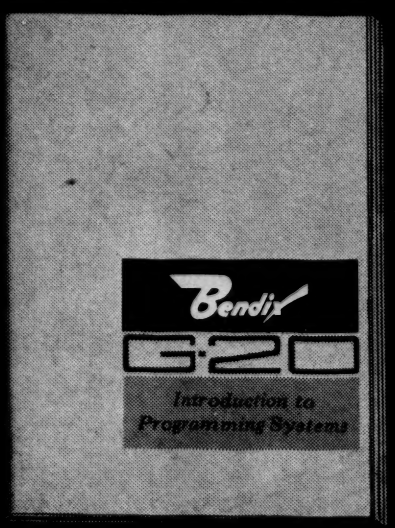
UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY.

Avco

AVCO CORPORATION, 750 THIRD AVENUE, NEW YORK 17, NEW YORK

BENDIX
G-20 COMPUTER
'SPACE'
PROGRAMMING





GIVES YOU DOWN-TO-EARTH RESULTS

SPACE—the Bendix G-20 Automatic Programming "package"—sets new standards for ease of use, power and efficiency. Designed in concert with the G-20 computer system, SPACE is complemented by numerous advanced equipment features. Here are the automatic programming methods which form an integral part of SPACE . . . and Bendix G-20 systems, large or small:

SPAR—Symbolic Assembly Programming. Allows the programmer to maintain direct control over all G-20 operations. Provides the efficiency of machine language programming without the complexities.

ALCOM—an Algebraic Compiler based on the international notation of ALGOL. Easy-to-use ALCOM permits the statement of scientific problems in natural mathematical language . . . simplifies and speeds problem solving.

COBOL—Common Business Oriented Language permits statement of data processing problems in natural business language for high-speed computer solution . . . makes flexible use of alphabetic, decimal, and special characters.

EXECUTIVE—provides automatic program scheduling and component assignment . . . permits maximum-efficiency in parallel processing and utilization of components.

See for yourself how SPACE . . . combined with outstanding equipment capabilities . . . has put the G-20 in a class by itself. Investigate today. For your copy of "Introduction to G-20 Programming Systems," write, wire or call:

THE Bendix CORPORATION

Bendix Computer Division

Dept. AF-30, Los Angeles 45, California

Services Vie for Larger Space Role

By Craig Lewis

Expanded military role in the national space effort is in prospect this year as a result of the Kennedy Administration's review of the program, a reappraisal that should produce the first realistic U.S. policy on the proper balance between military and scientific space goals.

The new administration promises more vigor and better balance in the space program, but the basic pattern of this new approach is still in the formative stage. During this key planning period, the services are pushing hard for a bigger, more diverse military space mission—and the Army and Navy are campaigning equally hard to keep the Air Force from completely dominating this new role.

The services are arguing that they are not permitted to explore and use space to its maximum potential for defending the nation. Elimination of the U-2 as a reconnaissance system and the recent demonstration with Sputnik VIII that the Soviets can launch an object from orbit—combined with the new political climate—are prime factors encouraging an expanded military space effort.

Shift In Policy

The current situation represents a swing of the policy pendulum back from the policy against any major military participation in the national space effort that set in during the hectic year after Sputnik I went into orbit. This was partially a reaction to the bitter interservice warfare that broke out over the dominant space role, and partially a symptom of the fact that few officials on the policy level really understood the impact of the dawning space age and its military potential.

First, the Advanced Research Projects Agency was established as the Pentagon space agency and absorbed all the services' important space programs. Then the National Aeronautics and Space Administration was formed late in 1958, and the Eisenhower Administration quickly developed a firm policy of shifting to NASA nearly all space systems and projects. Each service was left with a carefully limited area—boosters and reconnaissance and early warning satellites for the Air Force, navigation satellies for the Navy, communications satellites for the Army.

There have been small scale invasions of military areas during the past year. NASA decided it needed a space medicine capability of its own and organized to move into this area formerly handled entirely by the services. Late in 1960, the space agency decided to work on active communications satellites, although in an orbital area lower than the Army plans to use.

President Kennedy has sought to give the program top political leadership by putting Vice President Lyndon Johnson in charge of the U.S. space effort and by designating him chief of the National Space Council. The process of changing the space law to permit this arrangement has delayed Johnson's organization of his working team and obscured the type and style of power he will wield. A key factor will be whether Johnson will sustain a consistent high level of interest in space among his many other government interests.

The Vice President has commented that "the Defense Department has a very definite role and function in the field, which we recognized in the space act itself, and we must look to the services for leadership in space work."

A space study task force headed by Dr. Jerome B. Wiesner, White House science adviser, reached similar conclusions in a report to the President. This group specifically urged more attention to the military role and recommended that one of the services be given responsibility for all military space development work. The Air Force, which already has responsibility for 91% of the Defense Department space effort, would be the obvious choice for this assignment.

Coordination Attempt

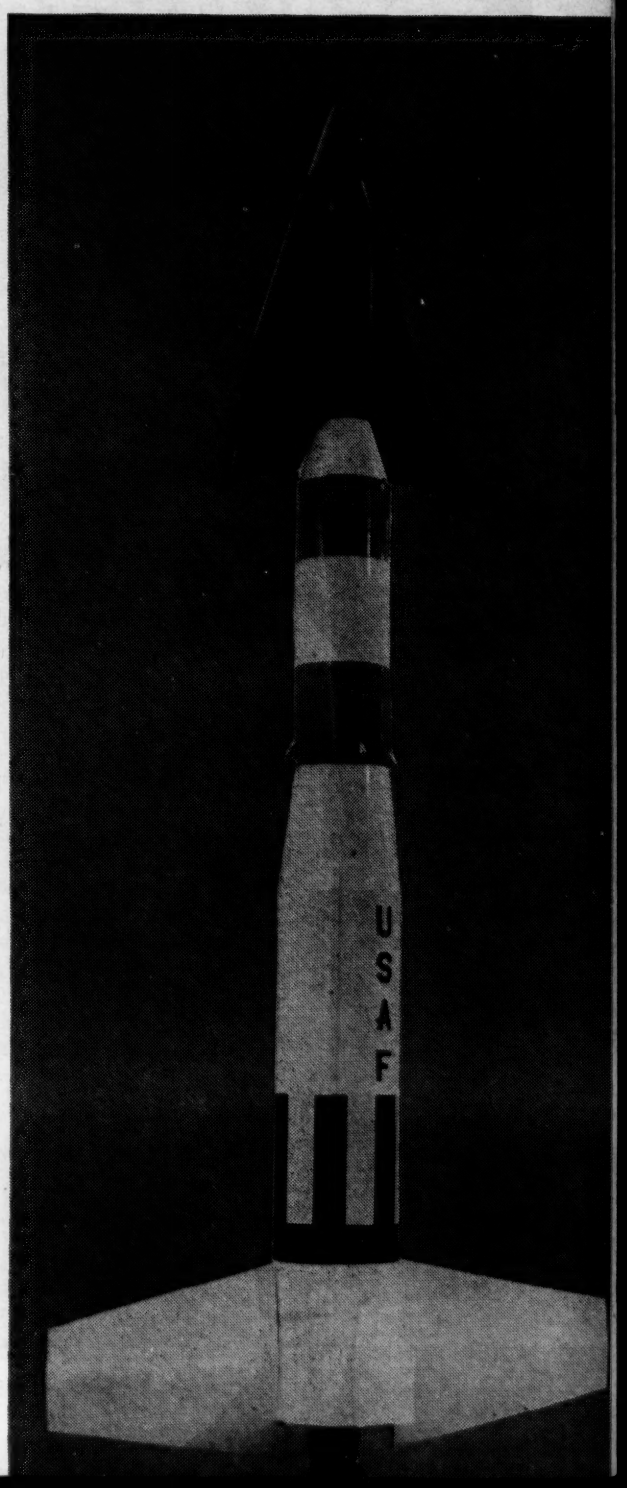
Both Johnson and the Wiesner report favor a better balance and better coordination between civilian and military space efforts. The space act made an attempt to provide coordination with the Civil-Military Liaison Committee, an ineffectual group that withered and finally ceased to operate last year.

This committee was replaced by the Aeronautics and Astronautics Coordination Board, which provides stronger, higher level coordination through the leadership of its co-chairmen—NASA Deputy Administrator Dr. Hugh L. Dryden and the Defense Director of Research and Engineering, Dr. Herbert F. York. Top space agency and Pentagon officials argue that this group has effected a high degree of agreement and cooperation between military and civilian groups and that little conflict exists.

These protestations have not concealed the actual conflict or the carefully planned Air Force campaign for a bigger space role that became apparent last fall and was publicly launched in January by Air Research and Development Commander Lt. Gen. Bernard A. Schriever. He told a Dallas meeting of the American Astronautical Society that current and planned civil space programs will not provide the systems needed to use space in defending the nation, and "the importance of satellites and other space systems as essential elements of our military strength is not fully appreciated."

Gen. Schriever also discussed a study, subsequently completed by an advisory group headed by Trevor Gardner, president of Hycon Mfg. Corp., designed to present an "uninhibited" view of military programs required for adequate use of space. Although prepared for the Air Force, this report will be available to the National Aeronautics and Space

BOEING DYNA-SOAR MODEL



←Circle Number 114 on Reader-Service Card

Council and undoubtedly would be useful in planning a larger military mission —and a larger share of it for USAF.

The Air Force had a broad, diverse space system development plan laid out last fall as it prepared to contest civilian domination of space. It includes such concepts as orbital bombers in the Positive Control Bombardment System, anti-missile satellites such as Spad, Random Barrage and Insatrac, and logistical systems such as Smart. The program also includes new launch vehicles under Project Phoenix and new manned spacecraft concepts such as Aerospace Plane, a vehicle under study that would take off under its own power, then orbit while scooping in oxygen and compressing it to liquid form for use as fuel in space.

USAF, like the Navy, wants to join NASA in invading the Army's communications satellite preserve. Csar is a study project aimed at developing satellites and a ground system for this purpose. Air Force also has bolstered its bioastronautics capability, consolidating all its space medicine efforts under a single ARDC coordinator.

The Army and Navy hope to counter Air Force domination of the space effort by promoting a joint space command, will all three services participating in the program. The Navy made an abortive effort in this direction in the summer of 1959, and still favors it.

Last month, the Chief of Research and Development, Lt. Gen. Arthur G. Trudeau, told the House space committee that military use of space is "too vital to be entrusted to any one service, but should come within the jurisdiction of centralized military control at the Department of Defense level, separate from the services." Trudeau was joined by Richard S. Morse, assistant Army secretary for research and development, in warning against duplication of programs, especially in the communications satellite area.

Along with its Advent program, which is to produce a system of satellites in stationary 22,300 mi. orbits, the Army is interested in geodetic, reconnaissance and surveillance satellites to help it perform its earth-bound mission. Army also is continuing to make a strong effort to get its Nike Zeus anti-ICBM system in production.

The Navy would like to add a variety of systems to its space program in addition to the current Transit effort. Primary among these is Sea Scout, a four-stage, solid fuel rocket composed of two Polaris stages and two NASA Scout upper stages. It would be used for sea launch to lend flexibility to current launching capabilities tied to fixed sites.

Navy also is interested in having its own communications satellite, and it is studying the Project Yo-Yo single pass reconnaissance satellite, the Project Renae weather satellite and the Project Skipper vertical probe for placing a cloud of small shot in space to destroy a satellite.

As the current military space programs have moved along, ARPA's role has diminished to the point where now it is actually an advanced research agency. Discoverer, Midas and Samos programs were transferred to USAF management over a year ago, Transit moved from ARPA to the Navy last May, and the Courier-Advent communications satellite program was shifted to Army management in September.

Since then, Spasur and Spacetrack have been transferred to Continental Air Defense Command to integrate satellite detection and identification with other Conad aerospace defense functions.

As elimination of the U-2 made alternate methods of reconnaissance more important, the Samos program was accelerated last year. The Air Force also decided to launch an alternate approach to the reconnaissance satellite concept and awarded contracts for the advanced E-6 satellite. Eastman Kodak is doing the photo intelligence system

Circle Number 116 on Reader-Service Card

work, and General Electric and Martin are designing alternate methods of returning the vehicle to earth. USAF also decided to launch Project Saint, with Radio Corp. of America as prime contractor, to develop a satellite interceptor system.

Air Force has launched two Samos satellite test vehicles. The first was unsuccessful, but the second went into orbit in January. Similarly, the initial Midas infrared early warning satellite test vehicle launch failed, while the second launch was successful. Significant advances, including the first recovery from orbit, were made during the past year in the Discoverer program, which contributes information to the Samos and Midas projects. NASA's two successful Tiros weather satellite launches last year also contributed somewhat rudimentary confirmation of the feasibility of orbital reconnaissance.

Manned Space Vehicles

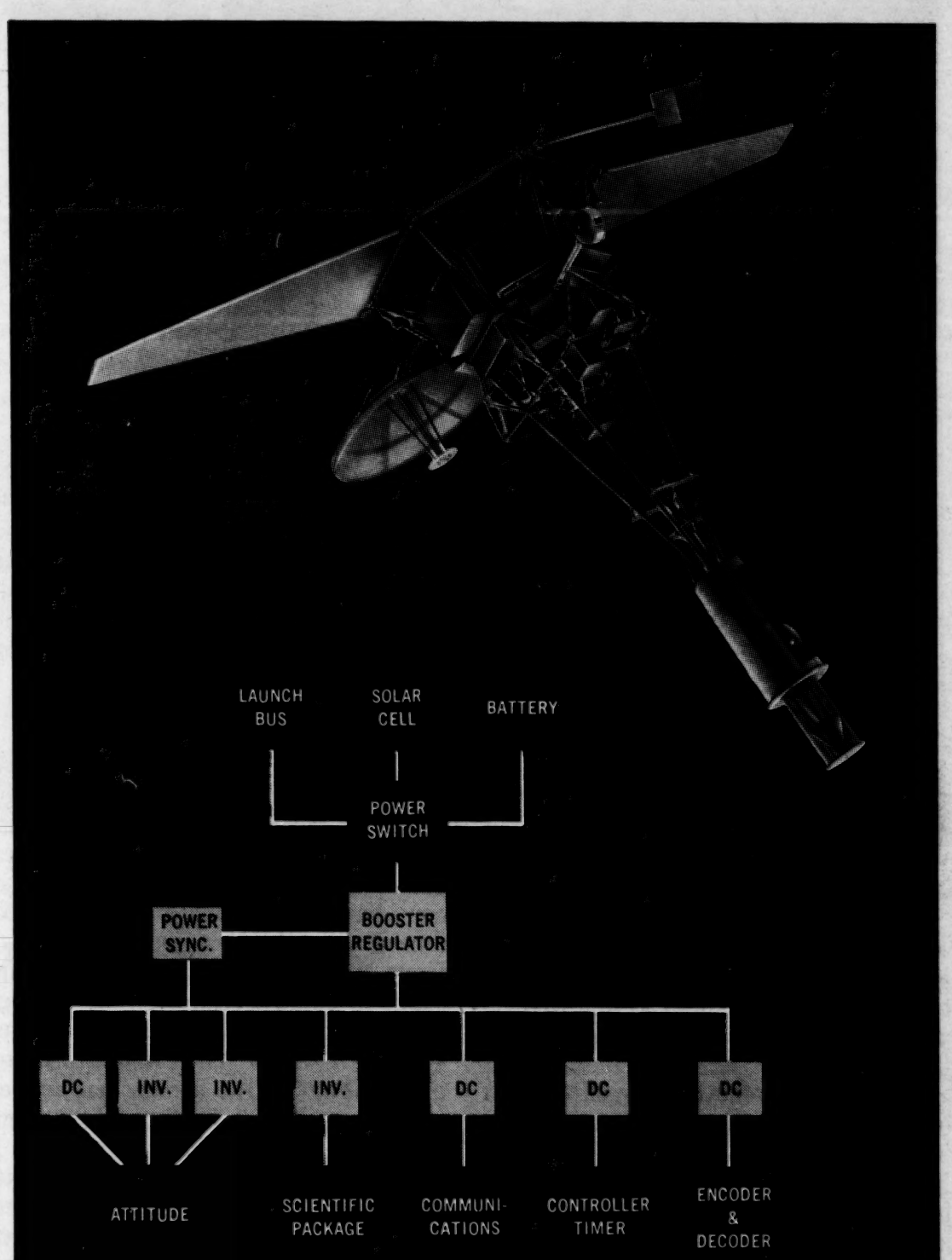
While work proceeds on these unmanned systems, the Air Force is working on manned space vehicles as design and development work progresses on Dyna-Soar. USAF recently decided to switch from Titan I to the more powerful Titan II to boost this hypersonic glider on its initial unmanned suborbital flights in 1964.

Here is last year's progress in flight testing the Discoverer, Transit and Courier-Advent vehicles:

• **Discoverer.** After a series of problems were solved, the first capsule was recovered last August from Discoverer XIII. First air catch was made with the Discoverer XIV capsule. Discoverer XX and XXI were launched last month within a 22-hr. period. Discoverer XX capsule failed to re-enter after four earlier successful recoveries. Discoverer XXI flight, which measured infrared radiation for use in the Midas program, marked the first successful restart of the Agena B second stage engine in orbit.

• **Transit.** This program has had two launch failures and has put three satellites in orbit. Transit I-B was launched in April and Transit II-A in June. Data from these satellites indicates the Navy will be able to reach its goal of 0.5 mi. accuracy with the Transit navigation system. Transit III-B was launched last month and apparently failed to separate from the second rocket stage. Navy said it still obtained valuable data. The second and third Transits carried piggy-back satellites which conducted separate experiments in space.

• **Courier-Advent.** Launch of the first Courier satellite, initial test vehicle for the Advent system, failed in August. Courier IB was launched in October and provided the Army with data on its voice and teletype relay systems during its 18-day transmission life.



TOTAL POWER SOLUTIONS...FROM ITT

THE MOST ADVANCED POWER CONVERSION JOB YET ATTEMPTED

Shown here is a simplified block diagram of the unique integrated power conversion system now being designed and manufactured by ITT for the Project Ranger moon probe, built for NASA by Jet Propulsion Laboratories. The over-all system provides 27 different DC and AC outputs at several discreet voltages, currents and frequencies . . . using ground, solar cell and battery power sources.

Total power capability such as this—for conversion, inversion, regulation and control—is readily available from ITT to solve your toughest power problems. Contact your ITT representative, or write for File AW-1368-2.

ITT and McCormick Selph combine their power and ordnance capabilities to provide the best in exploding bridgewire systems.

ITT Industrial Products Division
International Telephone and Telegraph Corporation
15191 Bledsoe Street • San Fernando, Calif. • EMpire 7-6161

static power conversion • instruments • closed circuit television

Circle Number 117 on Reader-Service Card

Booster Limitations Delay U.S. in Space

By Edward H. Kolcum

Washington–Dynamic U.S. space objectives continue to be hobbled by the long process of developing more powerful and more reliable launch vehicles which can transport men and advanced instruments on lunar and planetary missions.

Dozens of study and development programs are under way to overcome the U.S. deficiency in propulsion, but it is unlikely that long-range mission goals can be accelerated much before 1965 since the country cannot buy back the years it lost in booster development after World War II.

Although the National Aeronautics and Space Administration's long-range program has been criticized as reflecting a lack of urgency, the program can move no faster than development of its launch vehicles allows. The highly important multi-ton payloads which will bring practical scientific and propaganda returns to the U.S. must await development and qualification of Centaur, Saturn, Nova and Rover, or possibly an early breakthrough in large solids or hybrids.

Many payloads for these vehicles–to study the earth's environment, the sun, stars, universe and man's ability to be useful in space–have been selected, but development of payload components is on a forced stretch-out so that payload and booster will be ready simultaneously for flight.

Charges that the booster effort lacks urgency have come from industry, Congress and the Air Force, and it is possible that a new national booster agency will be sought this year to manage both military and civilian launch vehicle programs. For some projects, such as the first Saturn, the course for development is set. But added funding could advance some later launch vehicle operational dates and increase production rates of vehicles already developed, with the result that many scientific missions could be accelerated.

Wait for Boosters

Fast development of applications satellites is tied closely to launch vehicle production. The relay active communications satellite program, for example, must await Delta vehicle availability, which is not expected until May, 1962. The multiple-sphere Rebound passive communications payload, based on a stiffened Echo satellite, must await delivery of its Atlas Agena B vehicle in the spring of 1963 for launch.

Only one applications satellite is scheduled for launch this year, the third Tiros. This weather satellite will be essentially the same as Tiros II. Most of the $28.2 million alloted for Fiscal 1962 for weather satellites will be spent on development of the earth-oriented, polar-orbiting Nimbus, scheduled for its first launch in about a year. The stationary-orbiting Aeros, which only six months ago was on the long-range plan for launch in 1964, will not receive funds in the current fiscal year and does not now appear in the long-range plan.

Lunar Landing

Successful weather and communications satellites are seen as readily attainable practical applications of the space medium, but, from a psychological standpoint, manned lunar landing is considered the ultimate reachable goal during this decade. Defense Department has said if it were given the mission, it could accomplish a manned lunar landing in 1967. NASA last year set 1970 as its goal for this program, however, the agency has revised it to "post-1970" in the most recent long-range plan.

Acceleration of the manned lunar exploration program, the booster program and other research areas which will bring practical and psychological benefits depends on a sizable change in the attitude of the White House. Under the Eisenhower Administration, the attitude on space was one of reluctant acceptance, and there was refusal to arbitrate or even recognize the frequent interagency bickerings which always follow surrender of missions to a new agency.

It is apparent that Vice President Lyndon B. Johnson has been granted his wish to become a primary participant in the tough decision-making processes in the space program, and because of his hand in writing the 1958 Space Act it is unlikely that civilian domination of the space program will suffer. Both civilian and military program officials, however, look to Johnson to provide more sympathetic top-level support, and to back some of the hard decisions needed to provide rapid advancement of space objectives.

Under pending legislation, the Vice President would replace the President as chairman of the Space Council, a top-level decision-making body which never was used in the Eisenhower Administration. Work of the Space Council had been carried out in a large part by the space subcommittee of the Operations Coordinating Board, and by the NASA administrator. OCB last month was abolished by President Kennedy.

The civilian space program must continue to be responsive to the influence of the congressional space committees, which more than any other groups reflect the country's attitude on the prestige value of space successes.

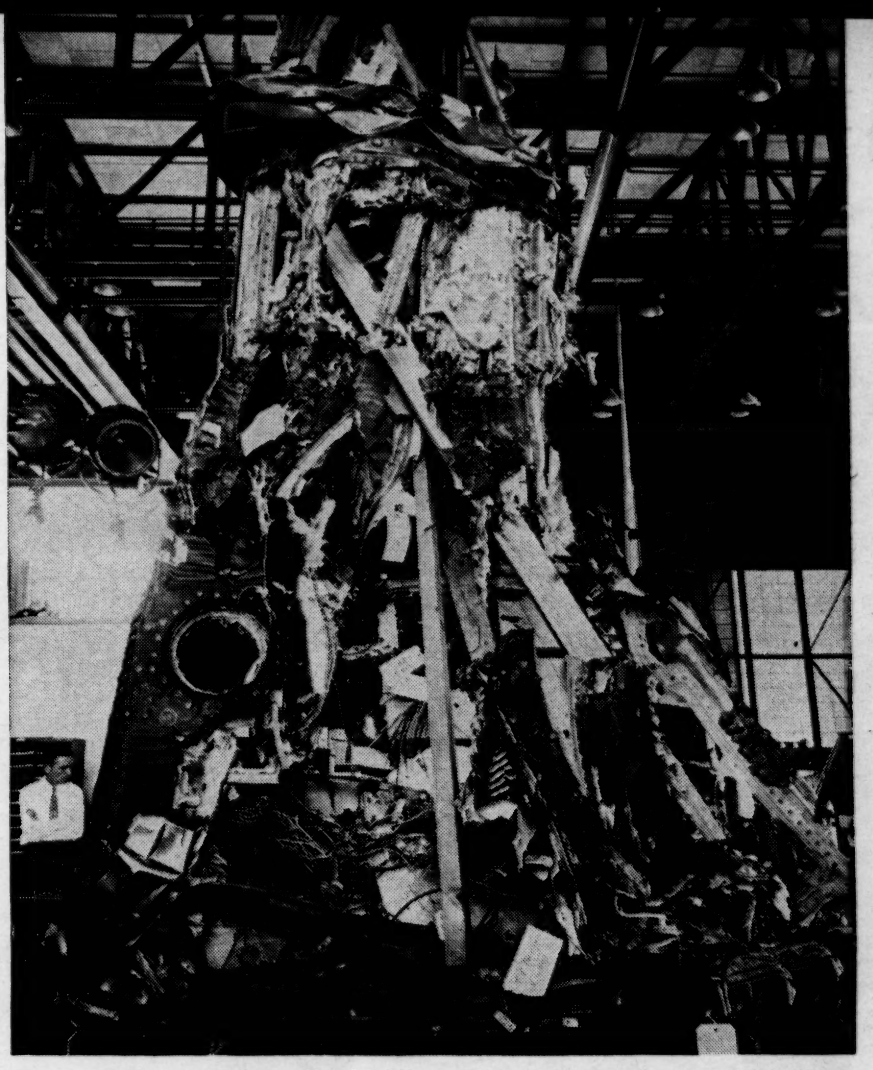
Program acceleration, to attain these successes earlier than now are planned, depends not only on money and the best use of talent, but on these immediate top-level decisions:

- **Validity of manned space flight** and level of support for the Apollo multi-man spacecraft program.
- **Nova concept,** i.e., whether it will be based on the Saturn or the F-1 1.5

NASA'S Planned Major Vehicle Launchings

VEHICLE:	CALENDAR 1961 (QUARTERS)					CALENDAR 1962 (QUARTERS)					CALENDAR YEARS			TOTALS
	1	2	3	4		1	2	3	4		1963	1964*		
MERCURY-ATLAS	3	2	2	2		1	1	1	1					13
MERCURY-REDSTONE	2	2	2											6
DELTA	1	2	1	2**		1	2							9
SCOUT	1	1	2**	1		1	1**	2**	2**		4	1		16
JUNO	2	1**												3
SATURN			1			1			1		5	4		12
CENTAUR		1	1	1		1	2	1	2		4	2		15
ATLAS AGENA B			1	1		1	2				4			9
THOR AGENA B						1	2	1	1		3	3		11
LITTLE JOE	1													1
TOTALS	36					29					20	10		95

*ADDITIONAL AGENA, SCOUT AND CENTAUR MISSIONS WILL BE SCHEDULED IN 1964.
**INCLUDES MISSION BACKUP VEHICLES.



PROJECT MERCURY capsules show results of a successful high-angle re-entry experiment Feb. 21, 1961 (MA-2 left) and a failure July 29, 1960 (MA-1 right) when an Atlas launch vehicle exploded 65 sec. after ignition. MA-1 impact was 10 miles off Cape at 400 mph.

million lb. thrust booster, and whether the best course is assembly and launch from orbit, or direct launch with super boosters.

These are holdover decisions which could become more costly the longer they are delayed.

The only concrete Nova conception for the follow-on to Saturn is based on the F-1 engine, and this program undoubtedly could be accelerated with more money. The Saturn C-3 could become Nova, but only preliminary work is under way on this conception. The F-1 engine, which was static tested at full power last month, is not scheduled for flight test until 1965.

Future Boosters

For simplicity and flexibility, NASA plans to base its launch vehicles on five classes after 1963, one-half the number of classes to be launched this year. Post 1963 launch vehicles will be:

• **Saturn,** which will use the same H-1 clustered configuration for the C-1, C-2 and possibly C-3 configurations. The initial three-stage Saturn C-1 has the H-1 cluster for booster, four Pratt & Whitney 17,500-lb.-thrust hydrogen-oxygen engines clustered as the second stage, and two of these engines as third stage. It will be able to put 10 tons into a low orbit, 3 tons on an interplanetary trajectory, and 1-2 tons on the moon on a soft landing. The C-2 will be a configuration in which a cluster of four 200,000-lb.-thrust hydrogen-oxygen engines would be inserted as the second stage, and the upper stages would be the same as C-1. Payload capability would be about double C-1. The C-3 is a possible Nova alternative, using a nuclear upper-stage engine.

• **Centaur,** which might well be the workhorse for unmanned missions. Vehicle could duplicate the recent Soviet Venus probe by carrying 1,450 lb. into a Venus or Mars flyby. It also can carry 8,500 lb. into a 300-mi. earth orbit. It uses a standard Atlas first stage and hydrogen-oxygen second stage. Rating of the 15,000 lb. Pratt & Whitney XLR115 engine is being increased to 17,500 lb. both for Centaur and Saturn.

• **Scout,** to be used for light (150-200 lb.) satellites. Development program of eight launches for this all-solid vehicle is scheduled for completion this year. Last month it flew its first satellite qualification flight by launching a 12-ft. inflatable sphere.

• **Agena** vehicles, using Thor and Atlas boosters, to bridge the weight gap between Scout and Centaur.

• **Nova,** which is being conceived as capable of placing 150 tons in a low earth orbit, 30 tons in a 24-hr. orbit, and 50 tons on the moon. There appears to be a considerable effort to base Nova on Saturn, perhaps with a nuclear upper stage, and use the technique of rendezvous and assembly in orbit, and launch from orbit.

Heaviest payloads to be launched this year by NASA will be the Ranger lunar orbiters, weighing about 650 lb., and boosted by Atlas Agena B. The agency's complete program for Calendar 1961 calls for 36 major launches, including 16 Project Mercury development and manned flights; eight vehicle development tests of Scout, Centaur and Saturn; four probes; one weather research satellite, and seven scientific satellites.

The Mercury program is scheduled to have nine Atlas, six Redstone and one Little Joe launch, with several Redstones to carry pilots on ballistic flights, and several Atlas-boosted manned orbital flights.

First Saturn Launch

Launch vehicle development tests this year include one shot of the Saturn booster with dummy upper stages, three Centaur launches with unspecified payloads, and four Scout satellite launches. Scout will be launched in all four quarters, Centaur tests will be made in each of the last three quarters, and Saturn in the third quarter, under present plans.

In addition to the Ranger spacecraft tests, which have payload designations P32 and P33, other NASA probes this year will be:

• **Electron density:** Scout will launch a 100-lb. package from Wallops Island to a 6,000-mi. altitude to measure the electron density profile and to study radio transmission at apogee. Payload is designated P21.

• **Rubidium vapor magnetometer:** A 70-lb. package to be launched from Atlantic Missile Range to an apogee of 120,000 mi., by Delta. The

NEW DEPARTURES IN MINIATURE

ULTRA-CLEAN INCUBATORS FOR M/I* BALL BEARINGS

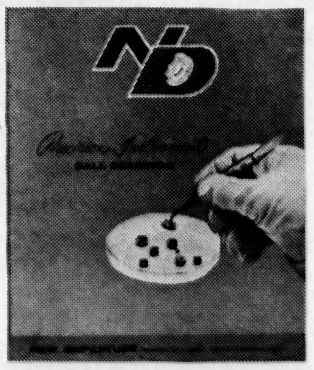
N/D'S NEW WHITE ROOM PROVIDES ULTRA-CLEAN ENVIRONMENT FOR M/I BALL BEARING ASSEMBLY

N/D announces a new White Room at Sandusky, Ohio incorporating the latest technological advances available today. This new room provides á virtually dust-free atmosphere so necessary for the production of Miniature and Instrument Ball Bearings of high reliability.

Environmental controls within the room hold temperature to plus or minus 1°... with maximum relative humidity only 40%. Final air filtration into room removes particles larger than 3/10 micron. A complete air change is made every three minutes. All authorized personnel entering the room are thoroughly bathed by air showers in two successive deduster chambers.

You can benefit from New Departure's 25 years of experience in M/I ball bearing production by calling your nearby N/D Sales Engineer. Or write Department L.S., New Departure, Division of General Motors Corporation, Bristol, Conn.

*Miniature and Instrument Ball Bearings.



SEND FOR NEW DEPARTURE'S M/I BALL BEARING CATALOG TODAY. WRITE DEPT. L. S.

NEW DEPARTURE

MINIATURE AND INSTRUMENT BALL BEARINGS

Circle Number 120 on Reader-Service Card

rubidium magnetometer will detect weaker magnetic fields than instruments previously launched. A fluxgate magnetometer will record direction of magnetic fields, and a plasma sensor will measure the flux of low energy particles. Probe is designated P14.

The two Ranger tests are expected to substantiate the basic spacecraft design, and will carry sensors for solar radiation, a magnetometer and a Lyman-alpha detector which will provide data on the hydrogen cloud surrounding the earth. If design data is substantiated, lunar hard landing Rangers 3, 4, and 5 will be scheduled for launch during the first six months of next year.

Scientific satellites planned this year include the Scout air density drag, Juno ionospheric beacon and Juno gamma ray astronomy experiments, all scheduled to have been launched during the first quarter. Remaining satellites in 1961 are:

• **Micrometeorite hazard:** A 112-lb. payload, to be launched by Scout from Wallops Island during the second quarter. Major instruments for this satellite, designated S55, will be detectors to get basic data on hazards of micrometeorites. Temperatures and accelerations will be determined by auxiliary instruments. Although data is basic, it will be used immediately to establish structural design parameters for the Snap 8 radiator. Langley and Lewis Research Centers and Goddard Space Flight Center are developing sensor experiments for the satellite Langley's experiment is 160 pressure cylinders made of four different metal gages. Penetration of a wall would be measured by escaping gas. The Lewis experiment consists of a series of gold grids protected by varying thicknesses of stainless steel, and each break will be measured. Goddard has devised a series of cards wound with layers of fine wires, which will be broken under meteorite impact load. Satellite will orbit from 280-740 mi.

• **Orbiting solar observatory:** A 350-lb. Delta payload designed to measure solar electromagnetic radiation absorbed by the earth's atmosphere. Payload S16, the OSO, will be solar oriented and programed for a 260-mi. circular orbit. Experiments will be an X-ray spectrograph, Lyman-alpha spectrometer, low and high energy gamma ray detectors, ultraviolet and X-ray detectors, and a series of sensors to determine the effects of space on materials.

• **Radiation belts:** An 82-lb. Delta payload which will contain sophisticated instruments in 10 experiments to obtain refined data on energetic particles. Designated S3, the satellite will orbit over a highly elliptical path—150 to 40,000 mi.—to detect and determine high and low energy particle number, direction and flux.

• **Atmospheric structures:** A 370-lb. Delta payload designed to make the first detailed studies of the density, composition, pressure and temperature of the upper atmosphere. It is designated S6 and will be designed to orbit from 125-650 mi.

Sounding Launches

Complementing experiments of these 36 major vehicle launches will be more than 100 experiments boosted by rockets for scientific and space flight mechanics experiments. The scientific sounding rockets are to study atmosphere composition and pressure, upper atmospheric wind activity, cloud cover, ionosphere, energetic particles, neutrons and ultraviolet radiation of stars.

Satellite, probe and manned space flight effort overshadows the broad NASA work in advanced research programs under way at the Langley, Ames and Lewis Centers and the Flight Research Center at Edwards AFB, Calif. These centers are working on problems associated with aerodynamics and flight mechanics, propulsion and power generation and structures and materials in these areas:

• **Manned aircraft:** flight efficiency; stability; control; aerodynamic heating; inlets and exits; high temperature materials; aeroelasticity and vibrations, and gusts and loads.

• **Missile and launch vehicles:** guidance; stability and control; maneuverability; aerodynamic heating; combustion stability; high-energy fuels; base heating; nozzles; pumps and turbines; nuclear engines; high temperature materials; heat sinks; ablation; structural efficiency; aeroelasticity; vibration; noise, and load.

• **Spacecraft:** Re-entry configurations; heat transfer; stability and control; landing and recovery; attitude control; guidance and navigation; chemical, electrical and nuclear rockets; chemical, solar and nuclear power generators; hot structures; thermal protection; materials in space; expandable structures; radiation shielding, and high speed impact.

Basic research will continue in the properties of high temperature gases, real gas effects and chemical kinetics, low density gas dynamics, magneto gas dynamics and plasma physics, and space physics.

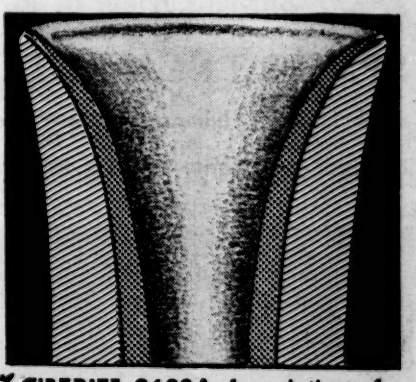
With the broad research program has come a requirement for added hypersonic facilities, and NASA hopes by next year to have a series of test facilities able to simulate Mach numbers up to 20, with 10,000F stagnation temperatures.

In addition to spacecraft, aircraft and missile engineering, NASA is expanding its life sciences program by forming a new research facility at Ames Research Center.

example...

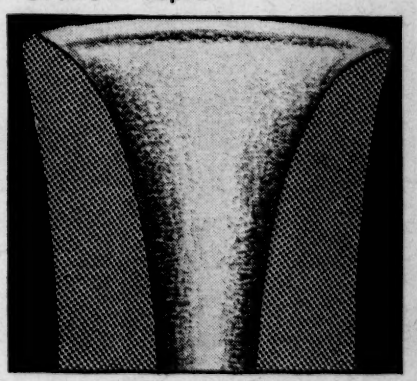
FIBERITE

INSULATION AT WORK IN POLARIS



FIBERITE 2630A formulation of graphite reinforced phenolic... 30% char depth.

Char Depth



Standard graphite reinforced phenolic 100% char depth.

The development of special Fiberite MX 2630A formulations reduce char depth of graphite reinforced phenolic molded insulations up to 70%, thus permitting the use of these materials in more critical solid propellant rocket motors.

Cut-away sections above illustrate reduction of char depth by utilizing Fiberite molding material.

EXPLORE FIBERITE

Missile engineers will find our research helpful in solving problems requiring materials for special performance. Write factory for bulletin "Fiberite High Temperature Insulating Materials."

SALES OFFICES IN PRINCIPAL CITIES

THE FIBERITE CORPORATION
Dept.
514 W. 4th Street
Winona, Minnesota

Circle Number 121 on Reader-Service Card
121

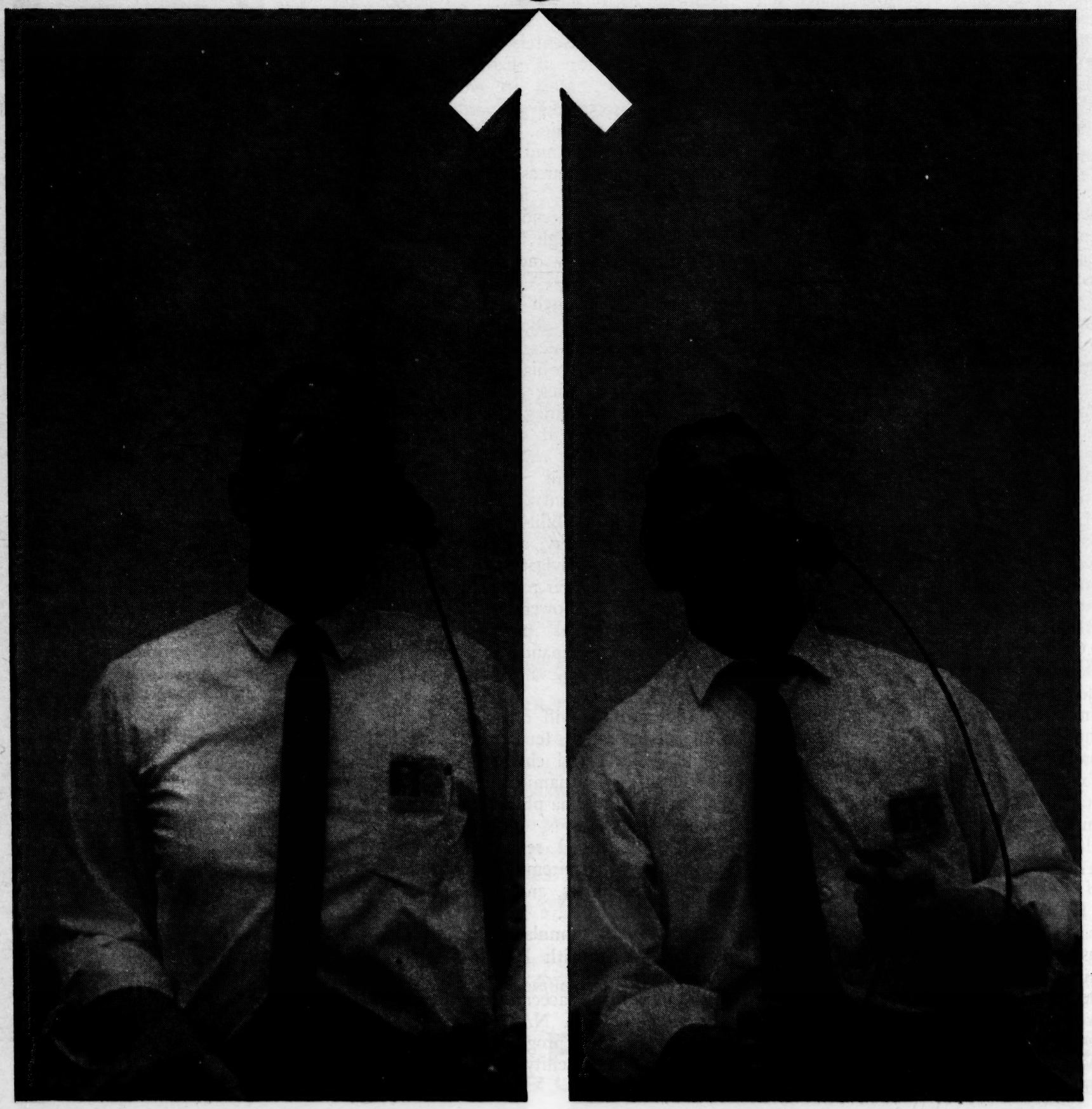
Performance is the test of **S**pace **T**echnology **L**eadership

The experience and creativity of Space Technology Laboratories in the field of space systems — both military and civilian — are documented in this record of accomplishment: Responsibility since 1954 for the over-all systems engineering and technical direction for the Atlas, Thor, Titan, and Minuteman elements of the U. S. Air Force ballistic missile program, and in such advanced space projects as Score, Tiros I, Transit 1B, and Mercury. Conduct of vehicle re-entry projects and the Pioneer I, Explorer VI, and Pioneer V advanced space probes on behalf of the Air Force, Advanced Research Projects Agency, and National Aeronautics and Space Administration. Contributions to these projects included design, fabrication, and instrumentation of spacecraft; over-all systems engineering and technical direction; direction of launch and tracking; and data reduction and analysis ● This performance demonstrates the STL creative flexibility to anticipate and initiate responses to the space challenge. To discharge its growing responsibility in Space Technology Leadership, STL is now broadening the scope of its activities. Resumes and inquiries concerning opportunities with STL are invited from outstanding scientists and engineers, and will receive meticulous attention.

SPACE TECHNOLOGY LABORATORIES, INC. P.O. BOX 95005A, LOS ANGELES 45, CALIFORNIA

a subsidiary of Thompson Ramo Wooldridge Inc.

El Segundo • Santa Maria • Edwards Rocket Base • Canoga Park • Cape Canaveral • Manchester, England • Singapore • Hawaii



Service Use Modifies Missile Concepts

By Russell Hawkes

Accumulation of military experience with missiles has begun to exert more influence on the design of their successors and is beginning to produce some new patterns of military administration.

These patterns are part of the complex process by which missiles eventually will become a tightly integrated, workaday part of the military inventory like airplanes, artillery and ships.

Purely technical factors must get first consideration and sound military and logistic principles sometimes must be compromised to get the first generation of a new family of weapons on the firing line. Now, as U.S. missiles gradually emerge from the status of recent inventions, one of the first logical progressions is that they be given the military virtue of mobility.

Logistic Efficiency

A simultaneous and equally important trend is the growing ease and efficiency with which the military services supply, maintain and use missiles. Logistic support for weapons as large and complex as ballistic missiles is as much a development problem as the design of the missiles themselves and requires much of the same sort of trial and error learning.

A few key missile programs illustrate the development of these trends:

- **USAF-Convair SM-65-A Atlas** intercontinental ballistic missile.
- **Navy-Lockheed Polaris** fleet ballistic missile.
- **USAF-Douglas GAM-87A Skybolt** air launched ballistic missile.
- **Navy-Bendix Eagle** long range air-to-air missile.
- **USAF-Boeing Minuteman ICBM.**

Atlas is especially significant as the product of the earliest U. S. long range ballistic missile program and as the first ICBM to reach combat-ready status. Along with the Douglas Thor intermediate range ballistic missile, it provides the main source of actual experience with such missiles upon which the operational and logistic echelons of USAF must base development of administrative methods.

In 77 launches since the first in June, 1957, Atlas has a score of 51 successes, 19 partial successes and 7 failures, according to the official Air Force classification. Of the total, 7 flights have been called operational. One of these was a failure and one other was partially successful.

Initiation of Atlas missile crew training at Vandenberg AFB soon revealed to USAF and Convair that automatic check-out equipment and procedures, although technically correct, could not handle all possible situations arising during a countdown.

Project Golden Ram was therefore established by BMD, SAC and Convair to reevaluate all phases of checkout and to incorporate in the operational IBM-card automated checkout system those research and development techniques and procedures which Convair crews had learned and performed manually at the Cape.

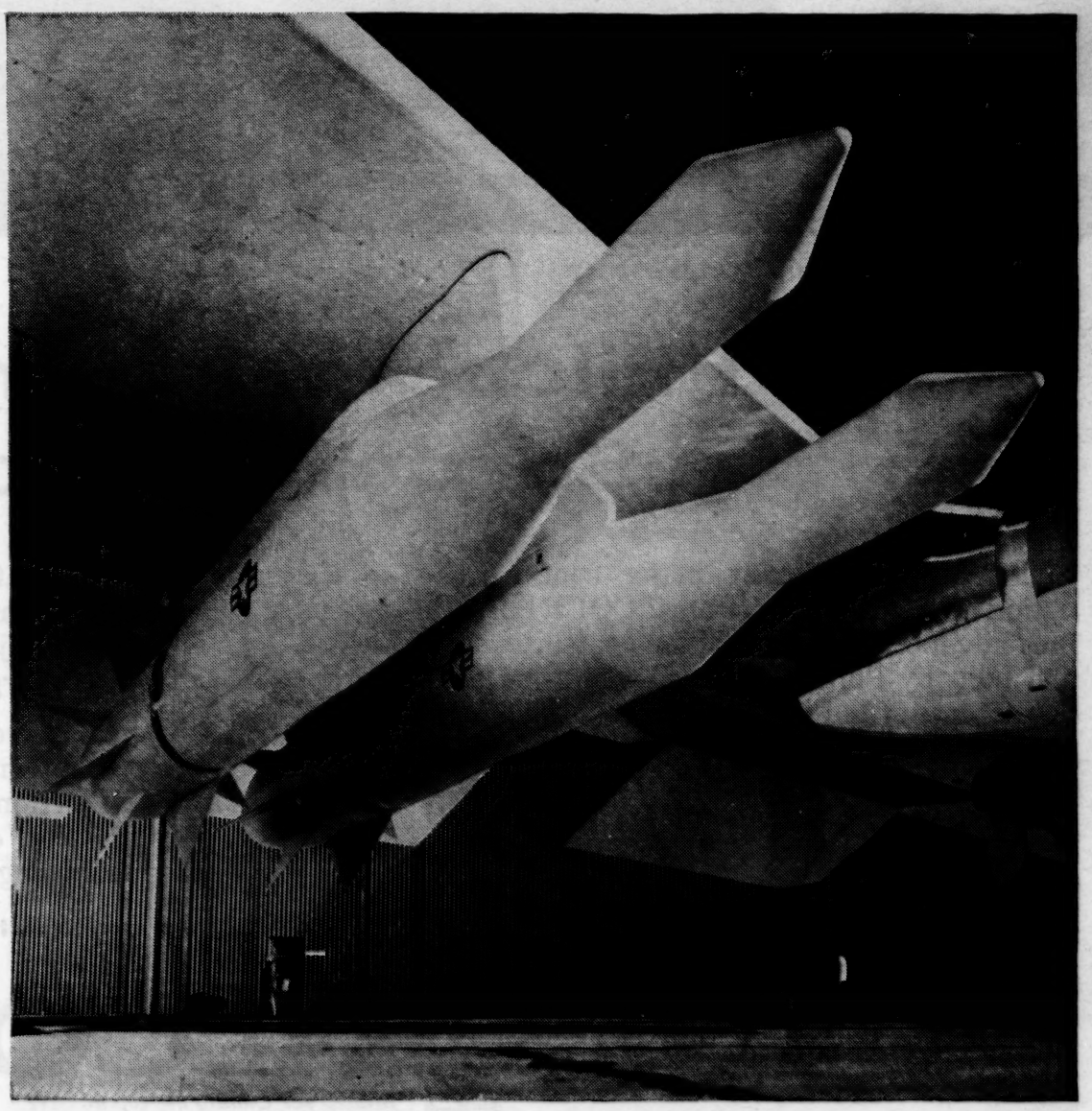
For example, a high-pressure valve stuck in the open position would give a no-go signal on the automated check-out system and the test would either have to be recycled or postponed. Convair crews had learned to cope with this situation immediately, with very little loss in countdown time, by suddenly droping and then sharply raising pressure to slam the valve shut. Under Golden Ram, this manual R & D procedure has been included on a punched card for the operational system.

Strategic Air Command's Emergency War Order has included Atlas since November, 1959. The first successful flight of an operational version was in September, 1959. The number actually in position to fire at Warren AFB and Vandenberg AFB and assigned to targets is estimated to be about 20. The learning process now going on in SAC Atlas-equipped units will be handled on to later programs and will improve their efficiency without the necessity of so much trial-and-error development.

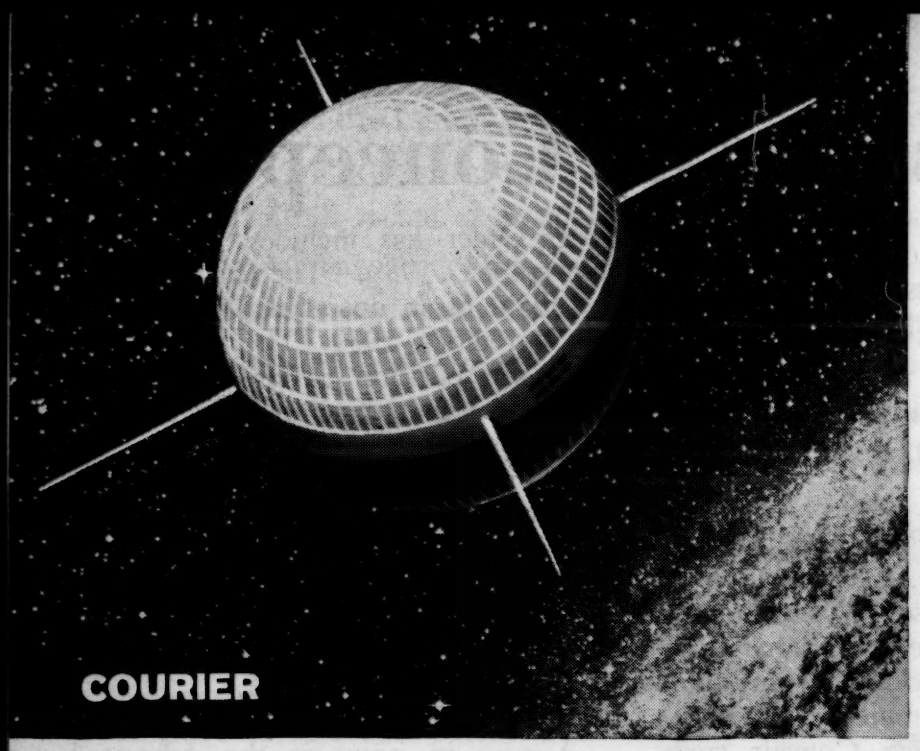
Automated Supply

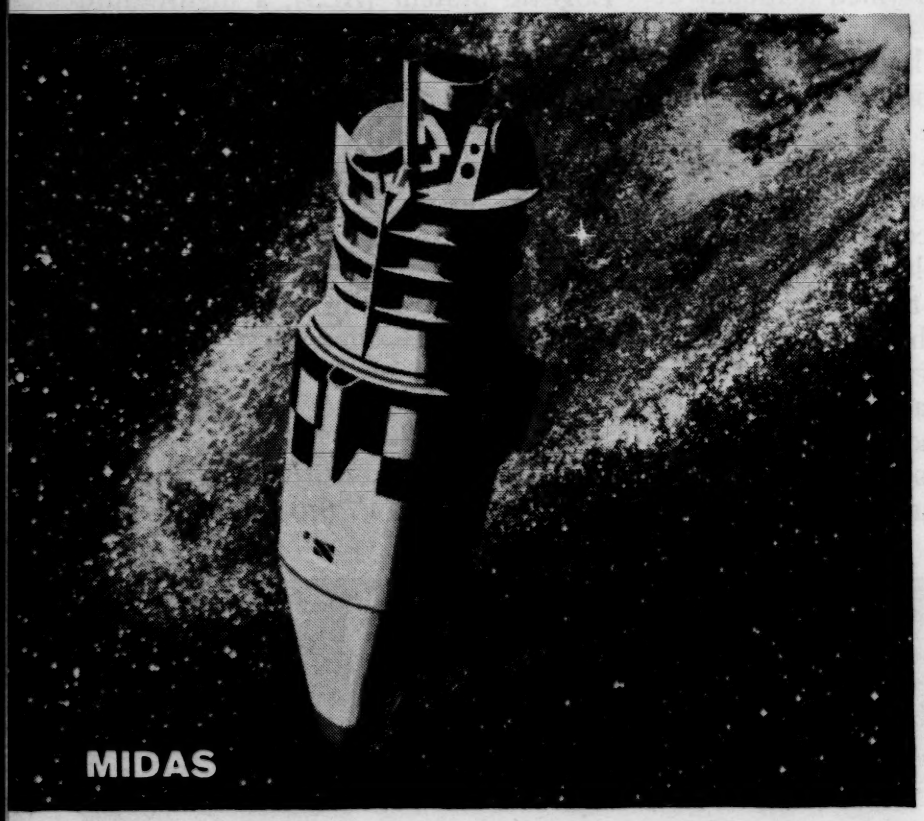
A case in point is the Advanced Logistic System (ALS), a highly automated system to record spare parts usage and feed replacement spares into the logistic pipeline to maintain the correct spare parts stock levels in the various supply echelons. The system is to support all the missiles, aircraft and other equipment in the Air Force after a service test program in which it will handle the spares flow to Atlas, Thor and Titan squadrons, Samos and Midas units and Bomarc interceptor air breathing missile squadrons.

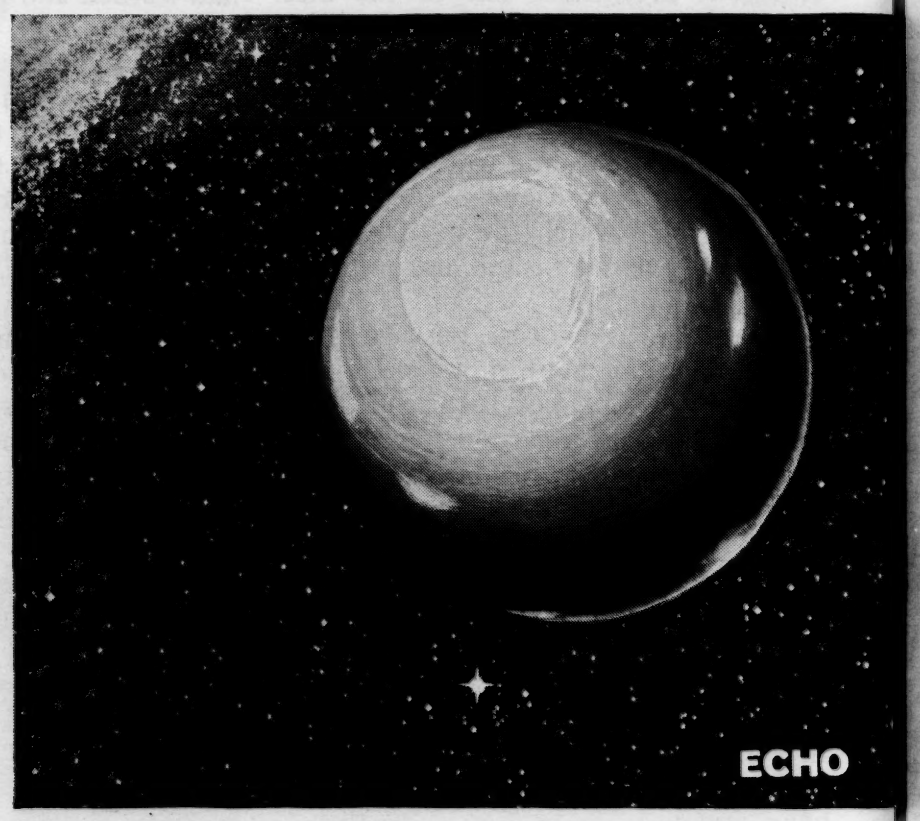
Of these missiles, Atlas is perhaps the most representative of the approaching logistic problem and was



DOUGLAS SKYBOLT ALBM







Philco Achievements in Space Technology

Philco has made many major contributions to the nation's vital space programs. COURIER, the world's first advanced communications satellite, was designed and built by Philco. Philco played a major role in the development and installation of the complex communications, command, tracking and data systems for the DISCOVERER program. Space-borne and ground communications systems for MIDAS and other satellites have been Philco designed. Philco developed and installed the tracking and receiving systems for the Air Force Passive Satellite Relay Link, which utilizes the ECHO satellite. In the field of human factors engineering, Philco has developed personnel subsystems for several major space projects. Philco also produces the world's largest 3-axis satellite tracking antennas.

These achievements are dramatic evidence of Philco's ability to integrate its extensive resources to the design and production of the most sophisticated electronic systems. For capacity, facilities and experience in space technology, look to the leader . . . look to Philco.

Government and Industrial Group, Philadelphia 44, Pennsylvania

PHILCO®

Famous for Quality the World Over

Communications and Weapons Division • Communications Systems Division
Computer Division • Sierra Electronic Division • Western Development Laboratories

Circle Number 126 on Reader-Service Card

closely watched by SAC, Air Materiel Command and the Ballistic Missile Division of Air Research and Development Command. Under the Advanced Logistic System, all Atlas supply transactions are to be reported to an IBM 705 digital computer in the headquarters of the San Bernardino Air Materiel Area at Norton AFB, Calif., and the computer is to order the appropriate components from AMC's logistic system. The computer is to provide centralized control of line items with more than 76,000 separate stock numbers for Atlases up to and including the E model.

The computer can only do arithmetic and has to be supplied with assumed failure rates on which to base the purchase of spares. Purpose of the missile system's development program was to iron out repeatable and frequent failures, and consequently most of the assumptions had to be made about rare and random events. Because of the practice of concurrent development, the assumed failure rates had to be adjusted every time a new fix was cranked into the system development program. Some failure rate, however low, was assumed for each of the 76,000 line items which had to be stocked. The risk of having the massive Atlas program halted by a single failure could not be accepted.

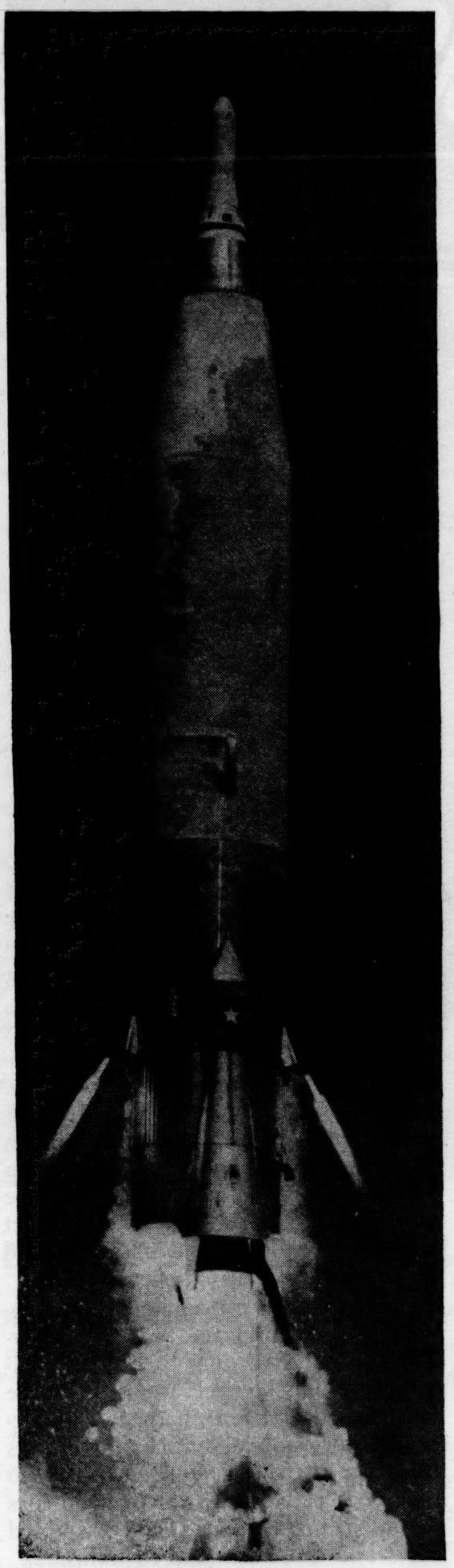
Too Many Spares

As it turned out, far too many spare parts were bought. Machinery was set in motion to correct the assumptions used by the automated system, and SAC 1st Ballistic Missile Division officers now report that it will be operating more accurately by May.

USAF logistic experts realized that if the failure rates for all 76,000 items were added, the rate of failures in the total weapon system would be so high that not a single missile could ever be in condition to launch. To date, only about 8,000 line items have been used and probably less than 3,000 of these have been called for more than once.

Aside from the cost of the overpurchase, the cost of administration for a large stockpile would have been considerable. USAF officers estimate it costs $160 per year to keep a line item stocked in the field and $110 per year to stock it at maintenance depots. It would have cost an estimated $12 million a year to keep the 76,000 line items necessary to support the 110 Atlas missiles which eventually will reach operational status. When the problem was recognized, Air Materiel Command set up a committee with members from all interested USAF commands and contractors to find a solution.

The committee found that 8,100 parts or components on Atlas missiles were classed as recoverable or repairable. The 76,000 line items are the pieces needed to repair the 8,100 recoverable components. The cost of technical data manuals for the 8,100 is about $200 per page. The committee concluded that it would be from 40 months to infinity before it became necessary to repair at least one of each of the 8,100 items. Some of the 76,000 line items would never be required. It was found that no bottom cost level below which repair is uneconomical had ever been determined for Atlas.



9,000-MI. ATLAS

After some study, the committee decided that any part or component with a value of less than $100 should be thrown away rather than repaired. Only two components costing less than that could be repaired for less than their initial costs. This eliminated 1,700 items from the list of 8,100 recoverable components.

By eliminating the component parts of these 1,700, the list of 76,000 line items is expected to be reduced by half and so will the cost of stocking them.

For items costing more than $100, the committee went through the list item-by-item to decide which should be repaired and which should be replaced. A few rare-failure items were given the double insurance of repairability and spares stocks. In general, USAF will plan to repair any component costing more than $400.

Polaris and Mobility

The Lockheed Polaris two-stage solid-propellant fleet ballistic missile gains special significance from two facts: it was the first long-range ballistic missile to be launched from a mobile, easily concealed vehicle and it has reached operational status and joined the retaliatory force in an extremely short time. The first three Polaris-carrying submarines have joined the fleet, making a total of 48 Polaris A1 missiles with a range of 1,200 mi. available for launch against the enemy if war were to start today.

Rear Adm. William Raborn, head of the Special Projects Office which developed the Polaris system, said that the 1,700-mi. Polaris A2 will reach operational status in spring of 1962 and the 2,500-mi. A3 will be ready by 1964. The first five George Washington class submarines will have to be retubed to launch the slightly longer A2 and A3 missiles but Raborn called it a relatively minor operation and said it could be done in one of the regular periodic yard overhauls given to naval vessels. All submarines after the fifth will be capable of launching any Polaris without modification.

As the first long-range, solid-propellant ballistic missile and the first of the breed to be teamed with a mobile launching vehicle, Polaris has attracted much interest as a potential mobile land-based weapon for NATO forces. It has also been suggested that cargo vessels be armed with Polaris and disguised as merchant ships, but the cruiser Long Beach is the only surface ship definitely slated to carry the missile.

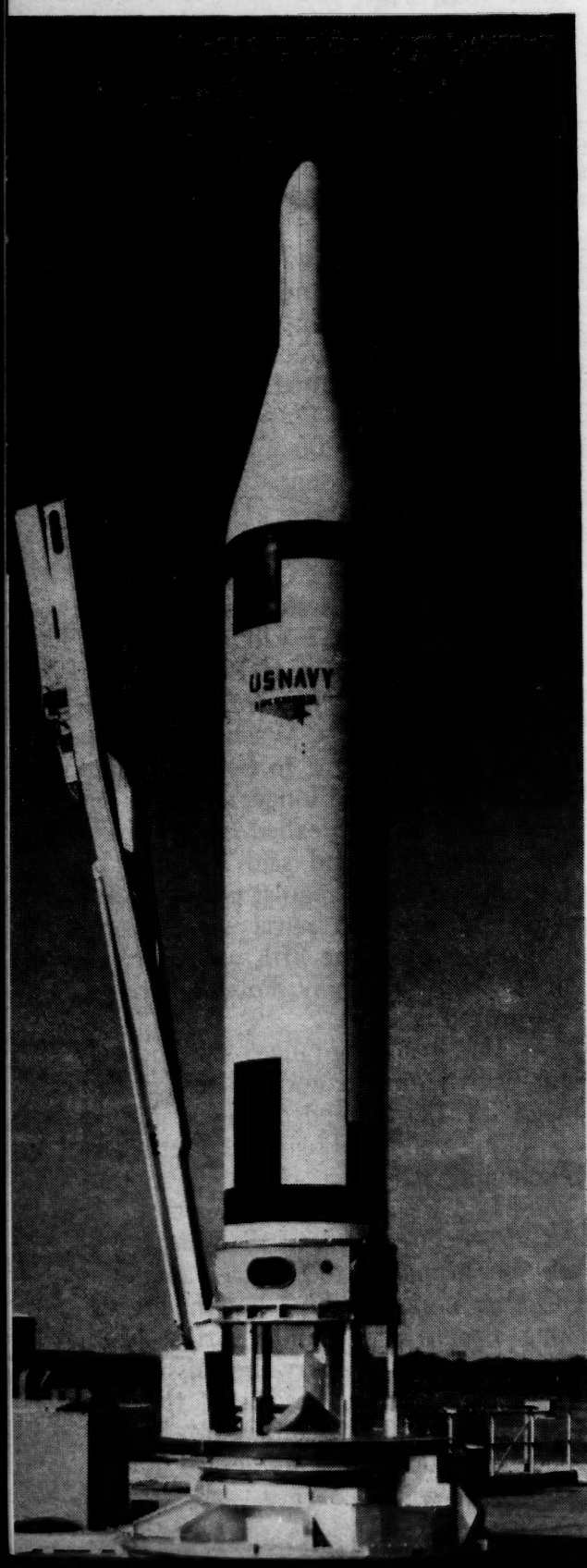
A key question has been that of authenticating firing orders to Polaris submarines operating submerged and at

a distance from any U. S. base because of possible communication problems.

A project sometimes called Vela Hotel is being conducted by the Navy to find improved methods of communicating with submarines underwater. The Very Low Frequency and Extremely Low Frequency bands are reportedly being investigated for this purpose as well as for submarine detection.

USAF-Boeing SM-80 Minuteman solid-propellant ICBM has made successful full-range flights down the Atlantic Missile Range and completed a series of silo launcher development tests involving the launch of tethered missiles at Edwards AFB, Calif. Upon the basis of these, an operational silo launcher has been designed and Army Corps of Engineers Ballistic Missile Construction Office is about to select a team of construction contractors to build the first Minuteman launch complex around Malmstrom AFB, Mont. The railroad-transported mobile Minuteman unit has undergone its USAF Development Engineering Inspection and a series of mobility tests have been conducted on the railroads of the western states.

POLARIS A-2 TEST VEHICLE



Minuteman Trains

First of the railway-mobile Minuteman units is scheduled to be combat ready by the summer of 1963. Eventually there are to be more than 100 such trains moving in random patterns between a series of railroad sidings in the western states. Each run, planned to present no predictable course or routine, would last for about two weeks and cover 900-1,200 mi.

It is in this mobile version that Minuteman is likely to make its most significant contribution, though the stationary, hardened Minuteman sites offer the same reliability and quick reaction time. Studies by USAF and Rand Corp. indicate that the mobility concept offers an exceptionally good prospect of surviving an enemy attack for a large part of the retaliatory ICBM force. It was impossible to choose such a concept for the early, complex liquid-propellant ballistic missiles. Mobility had to await the advance of technology to a stage capable of producing a relatively simple rocket like Minuteman.

A Minuteman train will carry as many as five missiles. The trains will be composed of 11-15 cars depending on how many missiles they have. The positions of the sidings which are to be used as Minuteman firings sites when war comes will be determined in advance and the missile on each site will get appropriate guidance programs tape-fed via the launch control system.

The mobility concept as it was applied to Minuteman was an afterthought but according to Boeing engineers, the missile itself would not have been much different had it been designed for mobile launching vehicles from the beginning. There will be no difference between Minuteman missiles intended for hardened and dispersed bases and those assigned to trains.

However, many ground systems will have to be completely new. An indication of the amount of new engineering involved may be the fact that the value of Minuteman contracts held by Boeing rose from $180 million to about $250 million.

Much of the extra money went to make up the difference between the benign environment of the silo launcher and the relatively more stringent one of the railroad car launcher. Earth movements and the effects of wind and weather are more significant above the surface and equipment must be designed to compensate for them.

The guidance problem is somewhat different because each missile has to get a new guidance program for every change of site. In the hardened base version, Minuteman guidance uses the North Star as its directional reference. In the mobile version, this has been replaced by a north-seeking gyro in the launch car.

Mobility adherents point out that since hardened bases are proving to be more costly than anticipated, the difference between a hardened and dispersed squadron of missiles and that of a mobile squadron is not very great. The complete equipment cost for a five-missile Minuteman train has been estimated at about $12 million.

USAF-Douglas GAM-87A Skybolt air launched ballistic missile is even less vulnerable to enemy action than Polaris in the opinion of some. Though hobbled by a funding stretchout, the development team of Douglas Aircraft Co., Aerojet-General Corp., Nortronics Division of Northrop Corp., General Electric Co., and a host of smaller subcontractors have brought the missile to the point of system compatibility tests including flights of the Boeing B-52 launch aircraft with dynamically similar inert models on the missile pylons. Initial drop tests are being made at Eglin AFB, Fla., to evaluate launch conditions and separation problems.

Skybolt for Britain

Britain's Avro Vulcan also is to be armed with Skybolt and one was brought to Los Angeles recently to be studied by the engineers who will tailor the missile systems to the airplane. Unlike the B-52, which is to carry four, the Vulcan will carry only two. Few changes in the missile systems are needed to complete the adaptation. The launch airplane's regular bombing-navigation system is used in the Skybolt mission. Since the Vulcan has a different bomb-nav system, there will have to be a slight modification of the electronic systems peculiar to the missile.

There have been brief but careful studies of a number of other aircraft as potential Skybolt carriers. So far, none have been chosen. The Convair B-58B was to have been used as a Skybolt carrier but the Defense Department decided not to order it into production. The B-70 cannot carry Skybolt either internally or externally as it is now designed. External storage in a Mach 3 environment would create an aging problem completely different from that for which Skybolt was designed.

Douglas engineers are considering the proposition that the transfer from a Mach .8 airplane to a Mach 3 airplane offers enough additional velocity to enable Skybolt to reach full range without

RELIABILITY *Proven*

RANGER

SATURN

CENTAUR

TITAN

ATLAS

AGENA

MERCURY

TITANIUM PRESSURE VESSELS by *Airite*

SPECIAL AUTOMATIC VACUUM WELDING CHAMBERS

Our own exclusively designed machines and equipment solve the problems of welding of Titanium.

SEMI-AUTOMATIC HEAT TREAT FACILITIES

Airite-developed furnaces provide extra heating capacity, minimum response time and unique quenching methods.

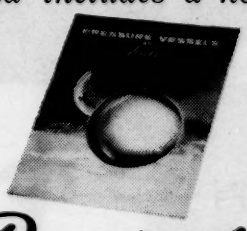
UNCOMPROMISING QUALITY CONTROL STANDARDS

Each production unit is thoroughly tested and additional operating and destructive testing is accomplished on selected units.

MINIMUM LEAD TIME REQUIRED

A separate, entirely integrated plant is devoted to the exclusive production of high-strength, thin wall vessels.

If your pressure vessel requirements call for the ultimate refinement in weight-performance efficiency, send for 12-page ***Brochure No. 141*** *which describes our complete facilities and includes a nomograph for approximating weights of spherical pressure vessels.*

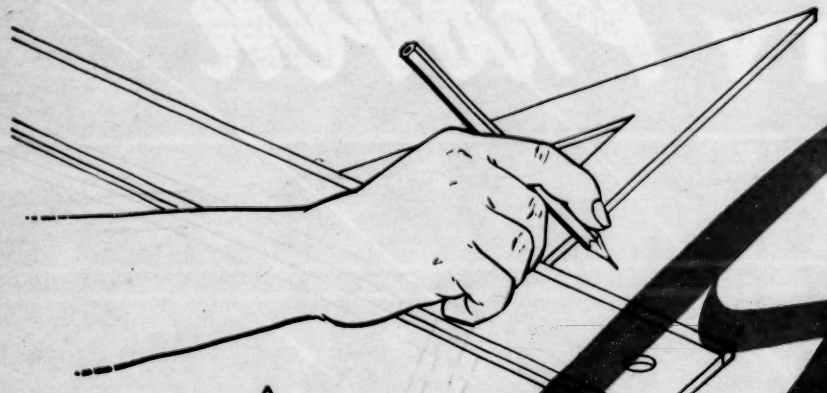


Airite Products

DIVISION OF THE ELECTRADA CORP.

3516 E. Olympic Blvd., Los Angeles 23, Calif. • AN 8-4137

From the home of *Planned Pioneering*

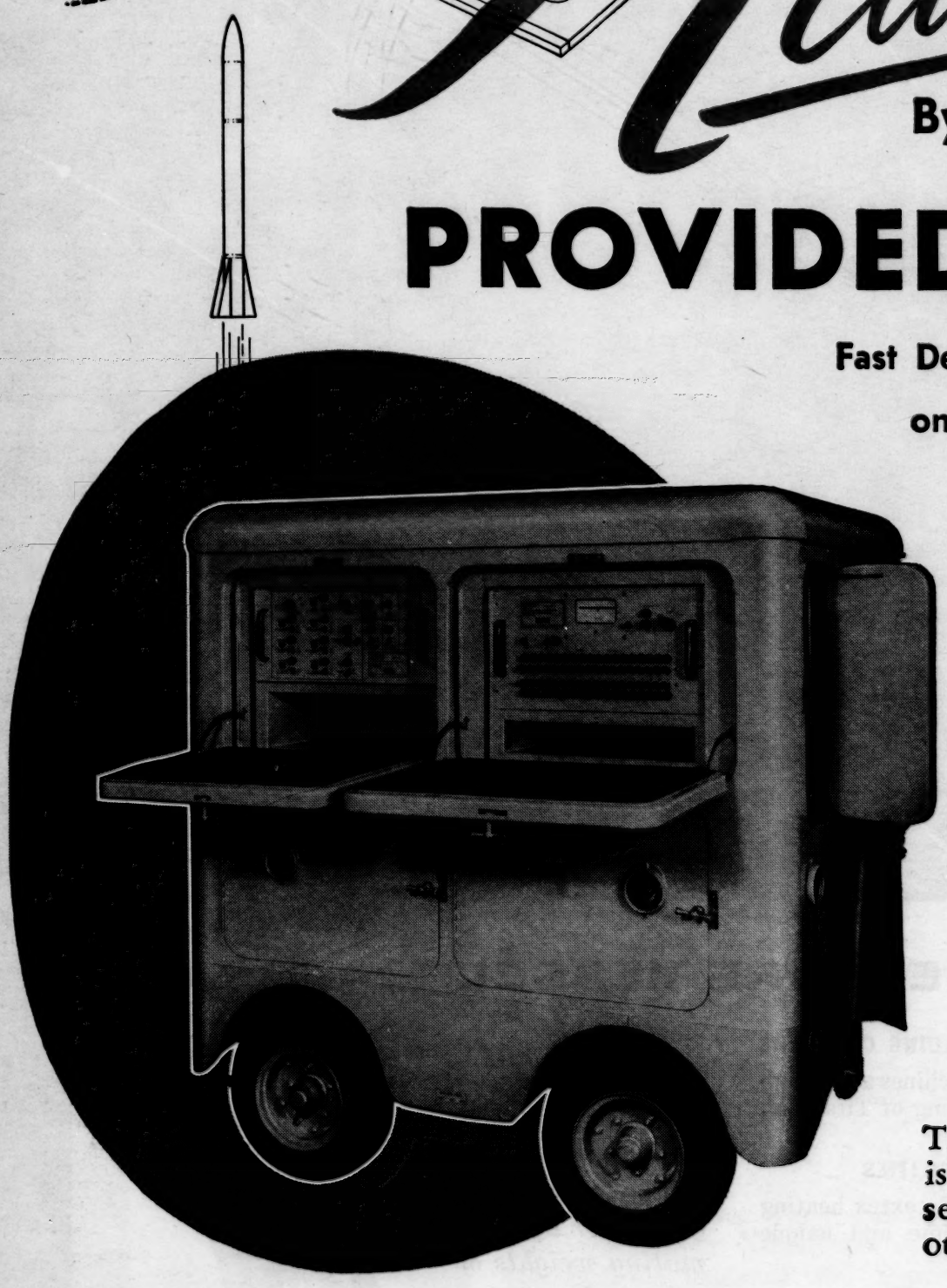


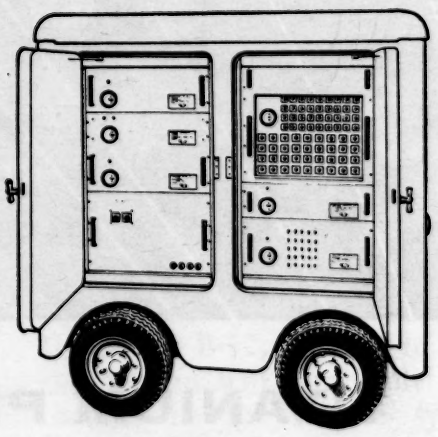
Actioneering

By CENTURY

PROVIDED BOEING

Fast Design — Production and Delivery on the Minuteman ICBM Portable Telemetry Check Out Cart





SIDE VIEW

This flexible engineering assistance is available for your systems, research, design engineering, or other related projects.

Suppliers of Ground Support Equipment to Military Aircraft programs and Commercial Airlines.

You can depend on Century *Actioneering* for the Answer . . .

century

ELECTRONICS & INSTRUMENTS, INC.

The Home of Planned Pioneering

TWX-TU 1407 . . . Phone LUther 4-7111

P. O. Box 6216, Pine Station, Tulsa 10, Oklahoma

Manufacturers of light beam galvanometers and magnetic assemblies since 1945.

Serviced by Systems Engineering Offices of Airsupply-Aero Engineering Division of the Garrett Corporation

• • • *Offices in All Principal Cities* • • •

Circle Number 130 on Reader-Service Card

its second stage. If this is true it would at least be feasible to use the missile with the B-70.

Difficulty of adapting Skybolt to new high performance bombers has brought the missile some criticism. Defenders of Skybolt argue that the speed of the airplane is scarcely relevant. They say that adaptability of the missile to cheaper, lower-performance aircraft is actually more significant. The relative speed of enemy interceptors is not important because the range of Skybolt is to be greater than the radius of action of any current Russian interceptors or air defense missiles. USAF is beginning to consider new ALBM tactics such as the roll-up action in which the missile load would be used to flatten a line of defenses leading to the target intended for aircraft internal bomb loads.

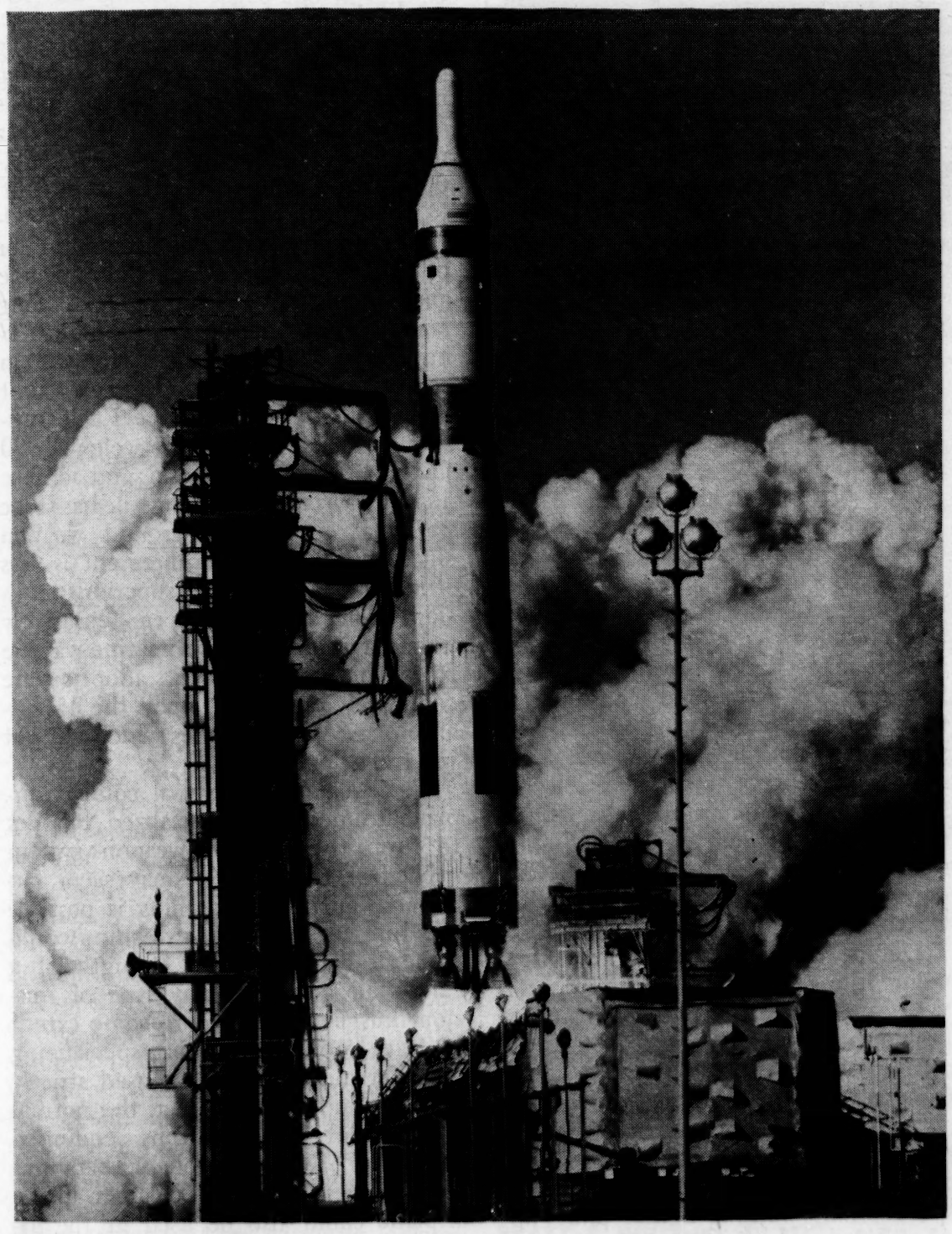
Higher speed would make possible quicker retaliation but it is being argued that if the U. S. stands by the doctrine of leaving the first blow to the enemy, a high ratio of flight duration to turn-around time will be more important than speed.

This would make an airborne alert program more effective in reducing the vulnerability of the retaliatory air force to that first blow.

Vehicle Integration

Like Polaris, and Minuteman to some degree, Skybolt is part of the trend toward closer integration of long range missiles and highly mobile launch vehicles and it shares many of the advantages claimed for both. It is difficult for an enemy to detect and attack the launch airplane before it is in a position to fire and it is easy to recall the aircraft up to the moment Skybolt is launched.

USAF has said that Skybolt will become operational in 1964. The leading contractors in the program report they see nothing to prevent this. As the initial drop tests now under way near completion, captive tests subjecting actual missiles to harder environments than those anticipated in flight

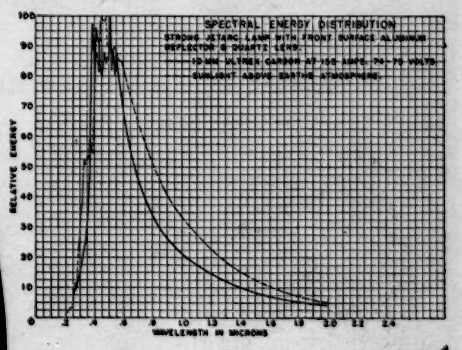


USAF—MARTIN TITAN J

Strong SOLAR RADIATION SIMULATOR

The Strong blown type Jetarc, the most powerful carbon arc, has proved to be the best artificial simulator of solar energy in the development and testing of space vehicle components.

Useful radiation is efficiently collected by first surface reflectors and concentrated at the reimaging point from where it can be projected by a quartz objective system in a pattern shaped to fit the work area. A circular radiation pattern totals 374 watts with an 80% uniformity of field or a total of 668 watts with a 60% uniformity of field. Higher or lower energy unit areas, can be obtained by variation in optics or projection distance. Large areas can be covered by multiple employment of lamps using either superimposed or overlapping pattern technique. Other, less powerful carbon arc sources, are also available for smaller work areas.



A continuous spectrum is available from .25 to 5.+ microns, with the spectral energy distribution very close to solar energy distribution above the earth's atmosphere.

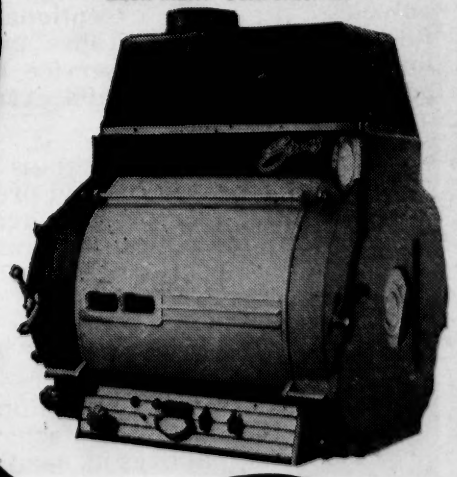
The Jetarc source can be oriented in any plane without loss of stability.

You are invited to consult with Strong Electric on your particular problems.

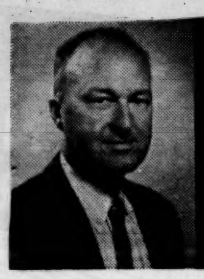
THE STRONG ELECTRIC CORP.
391 CITY PARK AVE. · TOLEDO 1, OHIO

Strong — A GENERAL PRECISION COMPANY

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION



CIRCLE 131 ON READER SERVICE CARD 131



PUMP PRIMERS

ARTHUR A. NICHOLS

ONE GEROTOR PUMP CAN SERVE SEVERAL FLUID SYSTEMS

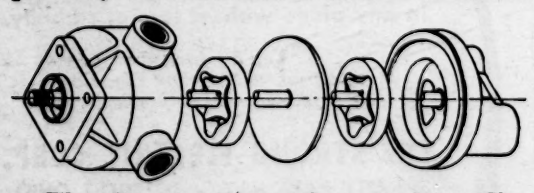
► Engine designers have been recently strongly attracted by Gerotor pumps which permit the incorporation of an extra pumping element in a separate chamber of the lubricating pump to provide fluid pressure for a control function or other use.

► **The Gerotor is a form of internal gear pump consisting of only two moving parts: an inner toothed element and an outer, meshing toothed element. The inner element has one less tooth than the outer and the "missing tooth" provides a chamber to move the fluid from the inlet port to the outlet. Pump capacity is measured by the volume of the "missing tooth" multiplied by the number of driver teeth and RPM.**

Fig. 1

► The unique construction of the Gerotor type pump permits aircraft systems designers to combine *several pumping functions* in a single pump housing mounted on a single pad and driven by a single shaft. Diversified systems such as lubrication, scavenging, low pressure hydraulic servo systems and motors up to pressures of about 1000 psi may be centralized in this manner.

Multiple function pump.



► **The Gerotor pump is a positive displacement type, delivering a predetermined amount of fluid in direct proportion to speed. It is a form of internal gear pump—simple and compact in basic design, (has only two moving parts). It is lightweight, valveless, provides exceptional performance at high altitudes and has low wear over a long service life. In addition, it is balanced and extremely quiet in operation.**

► Technical information plus complete custom engineering and precision manufacturing facilities are available to help you obtain the *right* pump to meet your specifications. Your inquiry is invited.

W. H. NICHOLS CO.

Makers of Zenith Metering Pumps and the Nichols Milling Machine "the miller that uses its head".

48 WOERD AVE., WALTHAM 54, MASS.

Circle Number 132 on Reader-Service Card

will begin and the specimen missiles will be autopsied to measure effects. Only then will the missile enter the research and development flight test phase in the Atlantic Missile Range in the usual sequence of autopilot programed flights followed by fully guided flights. USAF technicians and launch crews have already begun training with contractors to take part in later development phases. These men will become the cadres of operational units equipped with the missile.

Navy-Bendix Eagle is part of the trend toward closer integration of missile weapons with other parts of the military inventory. Though not as spectacular as the long range ballistic missiles, Eagle is one of the more significant projects now in development because it represents a new conclusion about the most economical division of responsibility between an air-launched missile and the airplane that fires it.

Concurrent with the development of the missile, Douglas Aircraft Co. was given a contract to develop a fighter to be teamed with the Eagle as a single weapon system and called the F6D Missileer. The primary mission of the Missileer-Eagle weapon system is to enable Navy's attack carrier task forces to establish local air superiority for either offensive or defensive purposes.

The project breaks with tradition in that a new airplane incorporating new technology is to be substantially slower than its predecessors. Navy fighter tacticians believe that a slow fighter equipped with a long-range, high-performance missile is about as effective against fast bombers as a fast fighter equipped with a similar missile. Besides, they say, it costs less and can remain on station longer.

Greater speed makes it possible to intercept incoming raids earlier but the proponents of the slow fighter concept argue that this advantage is more than offset by the large numbers of aircraft made possible by low cost, the long radius of action and long duration made possible by low specific fuel consumption, and the high aircraft availability percentage made possible by simplicity of systems and a relatively mild operational environment. Similar reasoning was developed by Rand Corporation in a study of fighter tactics for USAF.

Despite the strength of these arguments, the F6D is running into opposition and its future is considered problematical. The Eagle missile is relatively secure. Opposition is coming from government officials who cannot accustom themselves to the idea of paying for the development of a new airplane that offers no increase in speed. Many working fighter pilots oppose it because of an ingrained belief that superior speed will win fights.

Gen. Laurence S. Kuter, commander of the North American Air Defense Command, flatly opposes the introduction of the slow fighter concept in his command. He has said that the only advantage of an airplane like the F6D is its ability to fly a long combat air patrol. NORAD tactical doctrine does not include combat air patrols because the early warning radar lines to the north will detect incoming raids on the continental United States and defending aircraft will be vectored to the interception point by ground stations from the moment of takeoff.

Design of the F6D calls for a high aspect ratio unswept wing mounted high on the fuselage with a pair of Pratt & Whitney TF30-P-2 turbofans of 10,000-lb. thrust mounted in blisters low on the sides of the fuselage. The high wing would make it easier for small deck crews with low-bed service trucks to load or replace the Eagle missiles on the six rocket mounts without respotting the aircraft. Since Navy specifications ordered that the design be kept out of the transonic regime, the straight, high aspect ratio wing can be used to get good handling characteristics and long range at speeds approaching Mach .9. It is to have a maximum gross weight of about 50,000 lb. and a flight duration of 4-6 hr.

About half the total cost of the F6D-Eagle weapon system is accounted for by elements other than the airframe and propulsion of the F6D. A long range search, identification and tracking radar would be carried for use in conjunction with the target seeker unit in the missile. Each of the Eagle missiles is to be 15 ft. long, weigh 1,300 lb., have a range of 100 mi. and achieve a speed of Mach 4. The missile has some potential as an air-to-ground weapon since the guidance requirement is less stringent than in the air superiority mission. The F6D has been tentatively nominated for an antisubmarine warfare role. The prospects for its adoption are completely dependent upon the acceptance of ASW techniques which are not yet fully developed.

The idea of a universal combat airplane teamed with specialized missiles to form the type of weapon system needed at the moment may seem farfetched, but if such a thing is possible the limited space aboard ship would make it desirable. The strength of a carrier air group for any type of mission must be weakened to some extent to leave room for aircraft specializing in other missions. If it is used strictly as an air superiority fighter, the normal complement of squadrons equipped with the F6D would probably be about six airplanes. It could be larger if the airplane could also be used in the attack or ASW roles.

Economic Problems Color Missile Future

By Michael L. Yaffee

Missile development this year is facing more problems in economic and management areas than in technology, many missile manufacturers agree.

Those most frequently mentioned include depressed profit margins, intensifying competition, increasing low volume research and development work and need for engineering executives with business and administration skills.

Scientific and engineering problems still beset missile development, but they are essentially continuations of previous problems which have been solved successfully in the past at lower stages of performance and which do not appear beyond the grasp of current technological advance.

In the area of propulsion, for example, there is a continuing need for higher energy chemical propellants, both liquids and solids. Despite some competition between the two, and the imminent arrival of nuclear propulsion, missile engineers generally agree that both solids and liquids are destined to play important roles in the development of this country's space and missile programs for many years to come. At the same time, they say, despite the significant progress that has been made in this area, there is still a critical need for higher energy propellants.

The ingredients are there, says New York University's Charles J. Marsel. The problem is to put them together in high energy propellant mixes that are workable and practical.

Progress in Solids

In the solid propellant field during the past year, both composite and double-base propellant producers have made important improvements in the physical properties of propellant grains but have managed to make only relatively small gains—if any at all—in specific impulse. The existing conventional types of hydrocarbon solid propellants are still generally limited to a working specific impulse of about 245 sec.

Solid propellant engineers are aiming at specific impulse levels above 300 sec. One approach chemists are concentrating on is fuel additives. Aluminum powder is already being used. More recently, researchers have been working on the addition of boron, beryllium and lithium and their compounds. Of these, the most promising for rocket fuels currently appears to be lithium and its hydrides.

Propellant researchers are also devoting a great deal of effort to the development of solid fluorine oxidizers which offer perhaps the greatest potential of all for improving the energy content of solid propellants. Due to their inherent stability, fluorocarbons as such are of little value as oxidizers. What researchers are currently looking for are highly reactive but manageable combinations of fluorine and oxygen or nitrogen.

In the liquid propellant area, hydrogen-oxygen systems are well on the road to operational use. Pratt & Whitney Aircraft already has completed several static firings of its Centaur engine (AW Dec. 12, p. 26). With the Centaur system, specific impulse of liquid propellant rockets takes a big jump from the 286 sec. of current RP-1 and liquid oxygen combinations to 388 sec. The next step will be fluorine-hydrogen combinations which offer a slight gain in specific impulse to 398 sec. and a significant gain in density impulse—288 as compared to 168 for oxygen-hydrogen.

Bell Aerosystems is already at work on a fluorine rocket engine under a recently awarded Air Force contract.

Another important recent development in the liquid propellant field is the intended use of storable propellants in the advanced Titan. The particular combination slated for the Titan, nitrogen tetroxide oxidizer and a fuel combination of hydrazine and unsymmetrical dimethyl hydrazine, however, has a specific impulse of only 278 sec. There

PRATT & WHITNEY IR-115 liquid hydrogen Centaur rocket engine.

AN ACHIEVEMENT IN DEFENSE ELECTRONICS

HIPAR Proves Effective In Hercules Anti-Missile Test

This new General Electric *High Power Acquisition Radar* (HIPAR) more than triples the detection capability of the U. S. Army's Nike-Hercules System. Produced for Western Electric, Nike-Hercules System Prime Contractor, this General Electric radar provides high resolution target data at long range and high altitudes on bomber and fighter aircraft, air-launched missiles and tactical ballistic missiles. The effectiveness of this Improved System was demonstrated at the White Sands Missile Range on June 3, 1960, with the successful intercept and destruction of a Corporal Missile, and in August and September, 1960, when target Nike-Hercules Missiles were destroyed by their defending counterparts at altitudes to almost 100,000 feet and closing speeds near Mach 7.

176-06

HEAVY MILITARY ELECTRONICS DEPARTMENT
DEFENSE ELECTRONICS DIVISION • SYRACUSE, NEW YORK

Progress Is Our Most Important Product

GENERAL ELECTRIC

is both a need and an opportunity for storable liquid propellants with greater energy.

Some significant advances have been made in materials and structures, as in the development of light-weight, high-strength rocket casings and in high-temperature thermal protection systems for nose cones, nozzles and leading edges. At the same time, further advances along these same lines are generally expected and needed. A major problem in this area will be achievement of greater strengths in materials without loss in ductility. Towards this same end, materials and structures people are now learning to design around a material's brittleness limitations.

Perhaps the most significant development in the whole area of missile materials and structures during the past year has been the emergence of pyrolytic graphite and its alloys as new high-strength, high-temperature materials for rocket nozzles and re-entry vehicles (AW Feb. 13, p. 67). Unlike earlier thermal protection systems, pyrolytic graphite works primarily by radiation rather than ablation or heat storage.

Weight Saving

Due to its high thermal anisotropy, pyrolytic graphite obviates the need for much of the insulation now required in ablative re-entry vehicles. As a result, it is expected to save a significant amount, possibly up to 50%, in the overall weight of a re-entry structure such as the one used on the Polaris. Used in uncooled rocket nozzles for solid propellant motors, these new materials reportedly have withstood 60-sec. static firing runs at temperatures above 6,000F. Promising as these materials are, they still are beset by a number of problems, one of the most important of which is low ductility. As one possible solution to this problem, the materials producers have been given more design responsibility in order to tailor the final structure so as to take advantage of pyrolytic graphite's strong points and avoid its weaknesses.

In the fabrication of solid propellant motor casings, steel manufacturers have broken through the 200,000 psi. yield strength "barrier" and are now producing casings with yield strengths of 250,000-260,000 psi. Current research in the steel industry is now directed to achievement of 300,000 psi. Titanium the most easily welded of all beta material, falls somewhat behind steel in yield strength at approximately 200,000 psi, and the composite materials such as the filament-wound glass fiber structures are even further behind.

The newer titanium and composite materials, however, are pushing steel hard in the area of strength/weight advantages and, potentially, appear to offer more here than steel can, according to New York University's George Gerard. In terms of strength-to-weight ratios, steel casings currently appear to have a potential of 1 million inches; titanium, 1.6 million inches, and the composite materials, reinforced with high strength metal wires or strips, possibly 2-3 million inches. A good deal of research is now being under taken to realize these potentials on a production line basis.

It is in the economic area that the biggest problems facing missile management appear this year. There is still a great deal of uncertainty as to just what changes the new administration plans for this country's missile and space programs. Nevertheless, most missile contractors are fairly optimistic on their overall outlook. Individual company evaluations often are on the pessimistic side, however.

Many companies report that they are being severely squeezed by the growth in competition and reduction in profit margins.

Here, briefly, are some highlights from an AVIATION WEEK survey of companies representing a cross-section of the missile business.

• **Overall growth** is foreseen for missile business through the next decade with space programs more than offsetting an anticipated gradual decline in weapon programs. Most missile companies anticipate a rise in sales and profits but not in profit percentage. Many fear that actual profit margins will decline further.

• **Increasing government censorship** is said to be hampering essential exchange of technical information.

• **Scientific talent** is available, but there is poor utilization of what is available. The complaint of many companies concerned managerial or administrative personnel, many of whom have come from the scientific and engineering ranks without adequate grounding in business fundamentals.

• **Electronics** is considered by most contractors to be the area of missile business with the greatest growth potential.

• **To counter** increased competitive pressures, companies generally are planning to intensify their marketing efforts with emphasis on selectivity rather than on over-all expansion.

• **Trend toward consolidation** of in-house capabilities into military products groups appears to be growing.

• **Greater component and system** reliability, large boosters and lower costs are seen as the most pressing needs in the missile/space field for the future.

Majority of the executives surveyed anticipate a continuing rise in overall spending as a result of this coun-

CERTIFIED
CRYOGENIC
CLEANING
facility and laboratory!

If you are responsible for the flawless performance and cleanliness required of ultra low temperature transfer devices then you'll be interested in the exclusive certified cryogenic cleaning facility available at Dunbar Kapple.

WE ARE CERTIFIED TO CLEAN:
- Hose assemblies
- Duct assemblies
- Gimbal assemblies
- Expansion Joints, valves, etc.

TO THE FOLLOWING SPECS.
- Aerojet General—AGC-46118
- Specification for Cleaning Components of Liquid Oxygen-Hydrocarbon Fuel Propellant Systems AFBMD (ARCD) dated 5 July 1960
- Convair Astronautics—QCS-270-10-3—0-75001—0-75002—0-75035
- AMF Procedure Specification—ARS-1061-A
- Rocketdyne—RA0110-004
- Martin Company—Q.C. 106—804-1310000—327-9020000—327-9020001
- Aerospace Industries Association of American Incorporated. Handbook for Contamination Control of Liquid Rocket Propulsion Systems.

THESE EXCLUSIVE FACILITIES
are staffed with specially trained personnel, experienced in the cleaning, handling and packaging of critically-clean assemblies for aircraft and missile applications.

THE MOST UP-TO-DATE EQUIPMENT
is used in the cleaning and final inspection procedures including millipore analysis, black light and evaporation extraction analysis.

WHATEVER YOUR REQUIREMENTS DEMAND
and whatever the nature of your cleaning problem, including industrial cryogenic transfer devices, chances are Dunbar Kapple can provide the most economical solution.

OUR EXPERIENCED ENGINEERING STAFF
is available to assist you with recommendations or with technical assistance.

SEND YOUR SPECIFICATIONS
or an outline of your cleaning requirements for quotations to Mr. Hugh Lockhart, Sales Manager. Prompt attention will follow your request.

dk
DUNBAR
KAPPLE
DIVISION

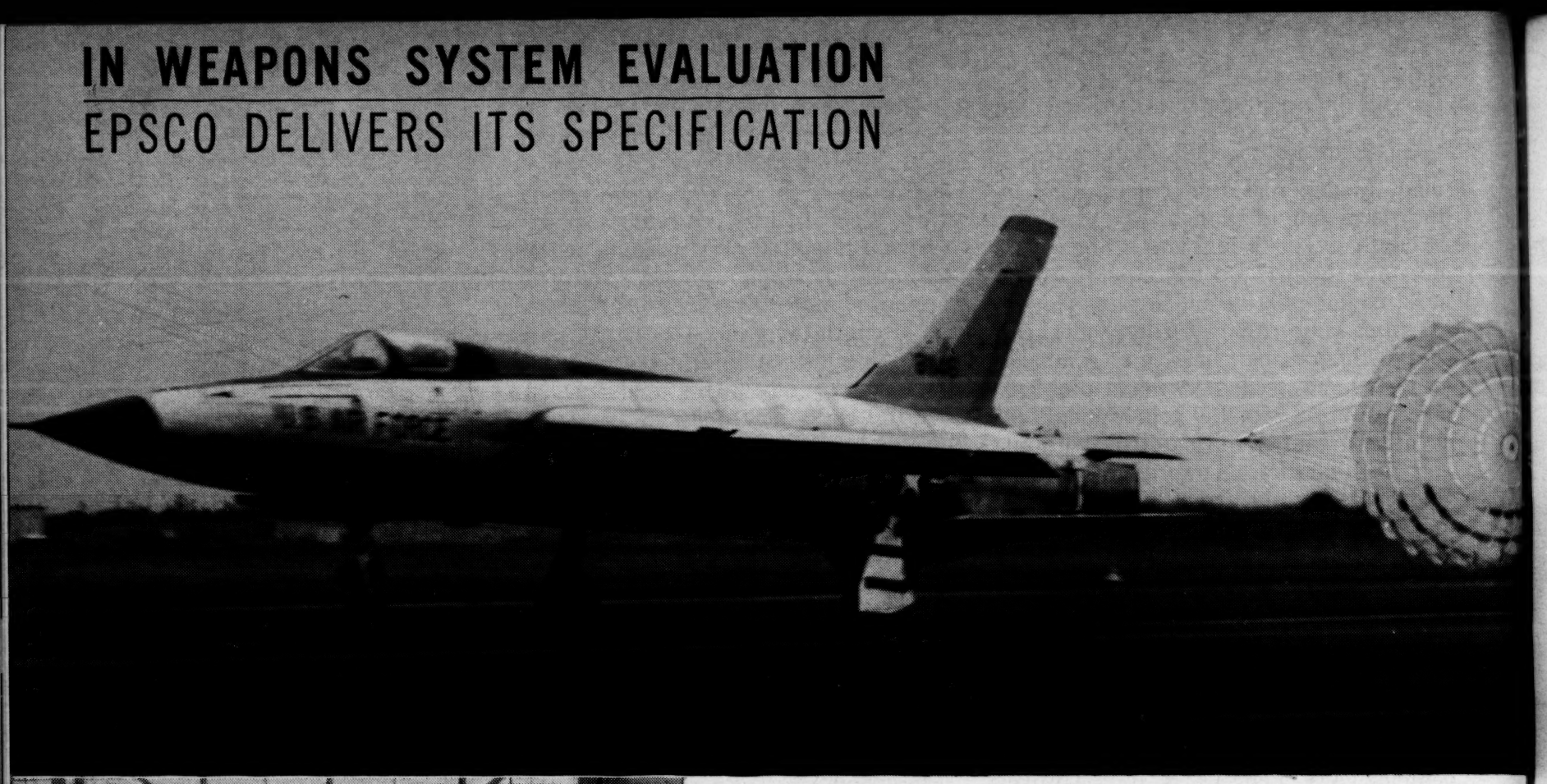
SPECIALISTS IN THE MANUFACTURE OF COMPONENTS FOR AIRCRAFT AND MISSILES

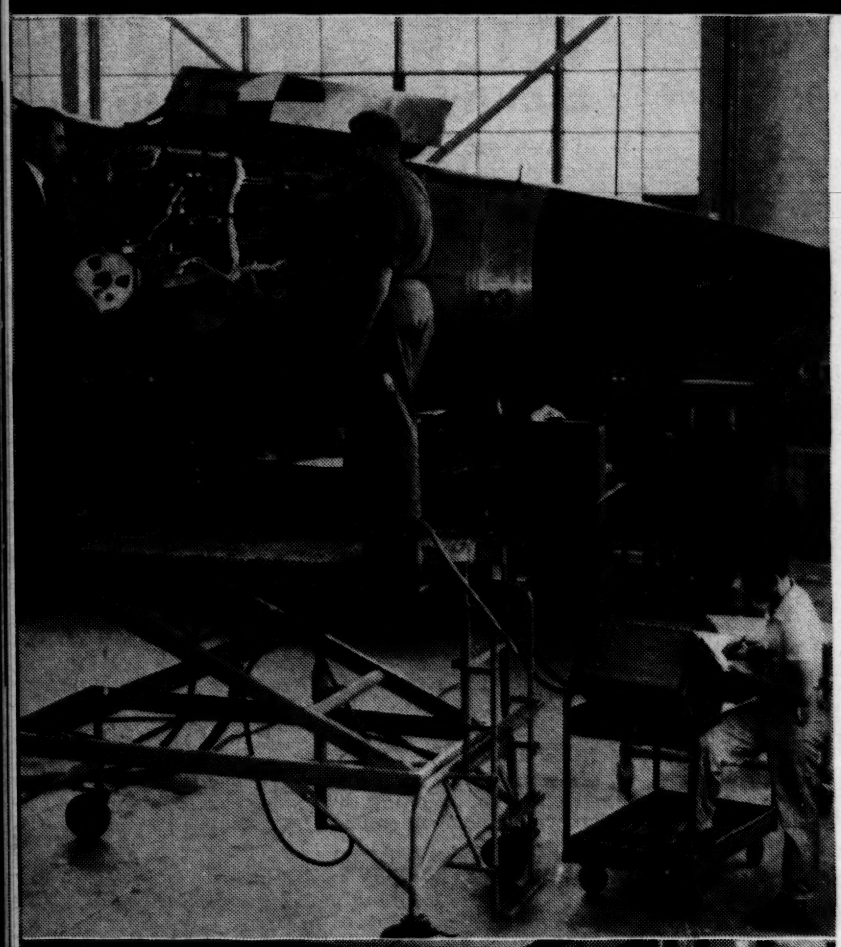
Dunbar Kapple Division
of DK Manufacturing Company
100 Island Ave. • Batavia, Ill.

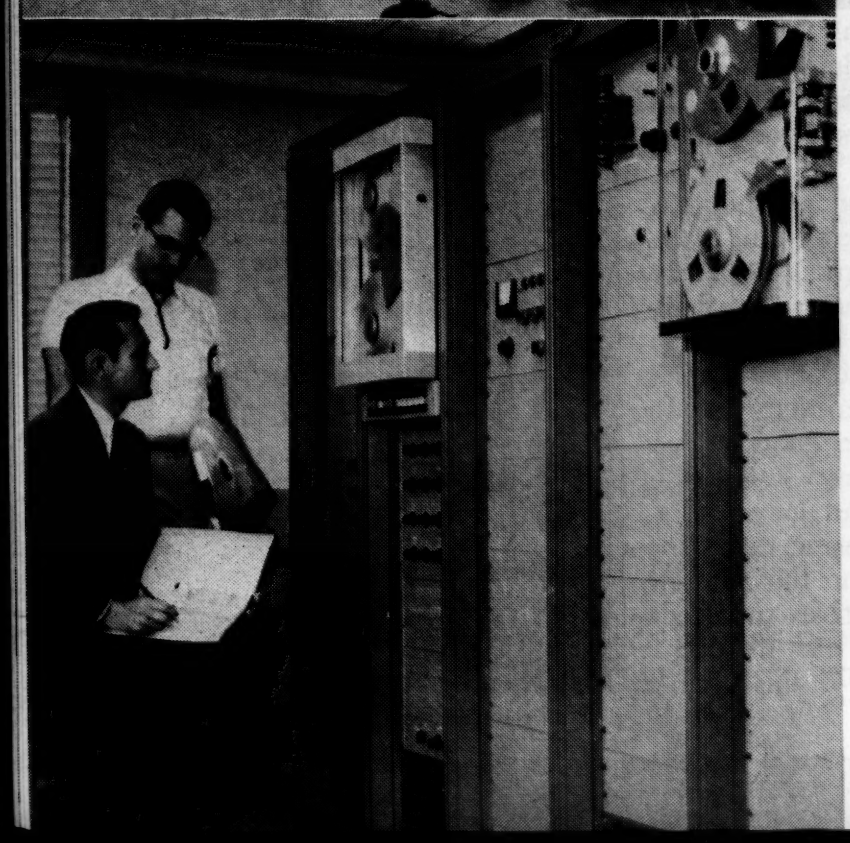
143

Circle Number 137 on Reader-Service Card

IN WEAPONS SYSTEM EVALUATION
EPSCO DELIVERS ITS SPECIFICATION







Currently in use at EGLIN AFB...

ADVANCED AERO/SPACE DATA SYSTEM DOES 10 DAYS' WORK OVERNIGHT

Since early 1960, this Epsco PCM Data Gathering System has been in use by Republic Aviation Corporation in its flight test program of the new F-105D Thunderchief Mach 2 fighter-bomber.

The Epsco PCM Airborne System samples, multiplexes, and digitizes 84 high- and low-level analog channels, then records these plus 15 auxiliary 13-bit digital inputs on a magnetic tape handler in the test aircraft. When the plane returns to ground, the digital tape is played back on the Epsco PCM Ground Station and the test data efficiently stripped, edited, and recorded in computer format for direct entry into Republic's IBM 704 computer. Through this high-speed data reduction process, all flight test information, including a full computational analysis of the F-105D's toss-bomb computer, is available by the next morning. This overnight speed with which data is made available cuts weeks from Republic's flight test data analysis time, materially speeding up the entire F-105D test program.

Epsco's PCM equipment was selected to meet the exacting test requirements of the F-105D weapons system because of such advanced design features as random programming, adjustment-free operation, system expandability, and operational versatility as well as inherent extreme accuracy and fast sampling speeds.

The advanced PCM system, Model PCM-S-4010, also may be supplied with airborne telemetering capability. For further details, write for Bulletin AE-Aero PCM.

Upper left: Epsco PCM Airborne System in nose of F-105D test ship. Adjustment-free system permits prolonged operation without requiring access to installation.

Lower left: Epsco's PCM Ground Station features extensive search and editing functions to strip out desired data for analysis, prepares data for direct entry into Republic's IBM-704 Computer.

Epsco SYSTEMS

A Division of EPSCO, Incorporated

275 Massachusetts Ave., Cambridge 39, Mass. UNiversity 4-4950

try's growing efforts in the space field. They believe weapon system spending will level off or even decline. In accord with this is their view that government spending for research, development, test and evaluation, which in Fiscal 1960 rose 23% above the average of the past four fiscal years, will increase significantly while the value of production contracts drops off.

The product mix at General Electric's Missile & Space Vehicle Dept. is an interesting example of this trend:

	1955	1960	1965
Ballistic missile work.	98%	40%	15%
Space vehicle work . .	0	40	65
Other	2	20	20

New Business Costs

Growth in RDT&E work, in itself a major factor in the industry's declining profit margin, has also created some unusual problems. Rocketdyne, for example, reports that the number of its programs has increased from 60 to approximately 200 during the past three years without any significant change in the total amount of dollars involved. At the same time, management of the increased number of programs has forced the company to spend more of its own money and time on organizational changes, cost controls, and new standards for research and development.

Too, the increasing number of smaller programs is forcing contractors to put more effort into long range and development planning and into applications engineering. It has also meant an increase in the number of bid competitions, another sore subject for many missile contractors, though missile contractors are not unique in this complaint.

Other reactions:

• **Lead time on bids** is too short. Those companies which have information leaked to them ahead of time can put teams to work on proposals immediately and thereby gain an important advantage. Amount of lead time should be increased and the number of bidders reduced.

• **Number of unqualified competitors** is growing along with the tendency of the government to select the lowest bidder rather than the most competent one. Short lead time prevents economical planning by industry.

• **Increased number** of new companies entering the propulsion field is diluting available funds and technical strength so as to hinder progress in this area.

• **Lack of firm,** long range planning by the government is a complaint by some, who add that the requirements for documentation, reports and back-up data are excessive.

• **Insufficient and incremental funding** of programs results in poor organization and increased program costs.

• **More continuity** is recommended in R&D funding. Instead of directing all R&D money in a contract to the development of a specific weapon, some should be spent on developing a basic understanding of the technology involved.

• **Government should bear** greater share of feasibility study costs.

• **Contract terms** generally protect the government but not the supplier. There is a lack of give-and-take in the missile business that distort the normal buyer-seller relationship.

• **Lack of adequate indemnification** for extra hazardous risks was the subject of some comment. The government so far has failed to recognize the need for compensation related to risk.

Several companies are planning to put more effort into their marketing and planning, but the trend is toward selectivity rather than overall hard-sell. Witness the following comments:

• **Major prime contractor**—We are putting greater emphasis on marketing, particularly in specified portions of complete systems, and also on selection of proposal requests due to their significant technical content and cost.

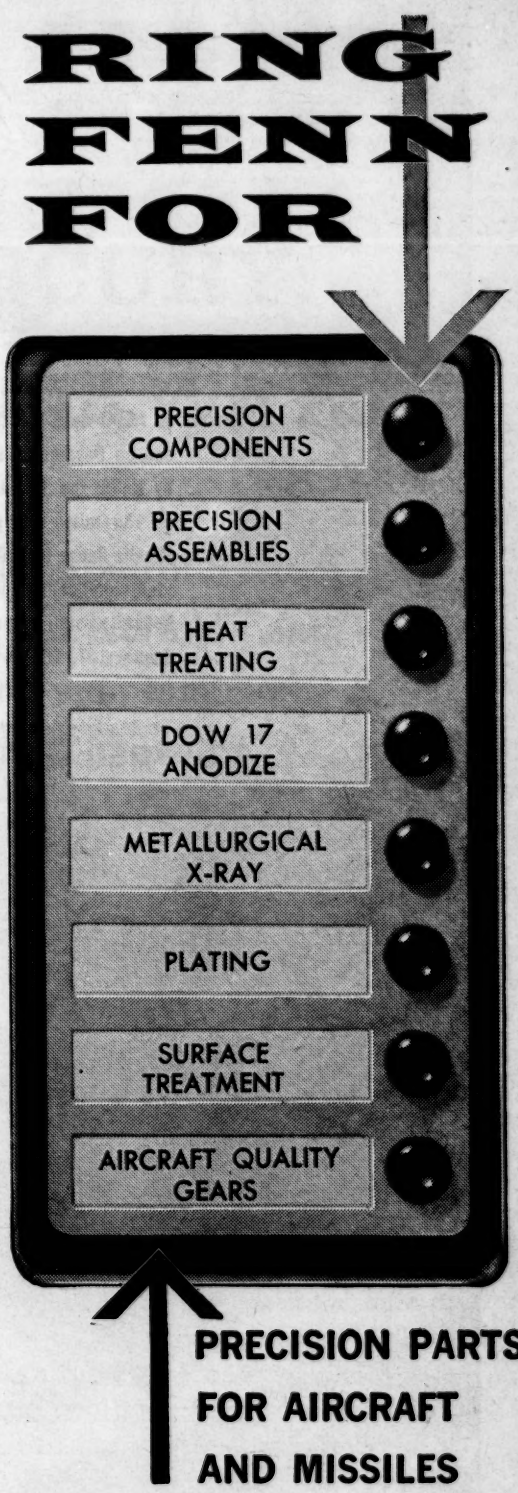
• **Electronics producer**—Company is putting more hard-sell emphasis on particular products rather than overall capability.

• **Ground support supplier**—We plan a more intensive sales effort, not an expanded one, and will be more selective in the business we go after.

In addition to the aforementioned efforts to bolster individual competitive position, there is the definite and growing trend among missile contractors towards intracompany consolidation of scientific engineering and marketing capabilities into what amounts to defense products groups.

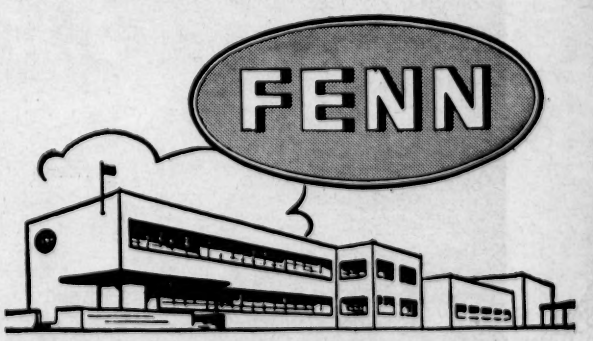
Representative of this trend toward consolidation are the many organizational steps recently undertaken by Minneapolis-Honeywell "to link the capabilities of the company's various divisions and enable them to undertake large system jobs." Using the missile equipment division as the nucleus, Honeywell organized a special systems division for the development and production of large integrated control systems.

The company's Inertial Guidance group in St. Petersburg and Aeronautical Division in Minneapolis were brought under single management as part of the company's military products group, which also includes the Ordnance Division and the Boston Division. To coordinate the activities of the different divisions in this group, Honeywell set up "a strong planning staff" which also maintains close liaison with the special systems division.



PRECISION PARTS FOR AIRCRAFT AND MISSILES

For many years Fenn has been entrusted to produce vital and complex components in large quantities for aircraft. Today, Fenn has the facilities and personnel experienced in machining of special metals and alloys required in the aircraft, missile, and nuclear fields. Fenn's ultra-modern plant includes the finest metal working machines, heat treating, plating, surface treatment, a metallurgical laboratory, and resident air force inspection. We welcome the opportunity to discuss your requirements. Write for copy of *Fenn Facilities.*

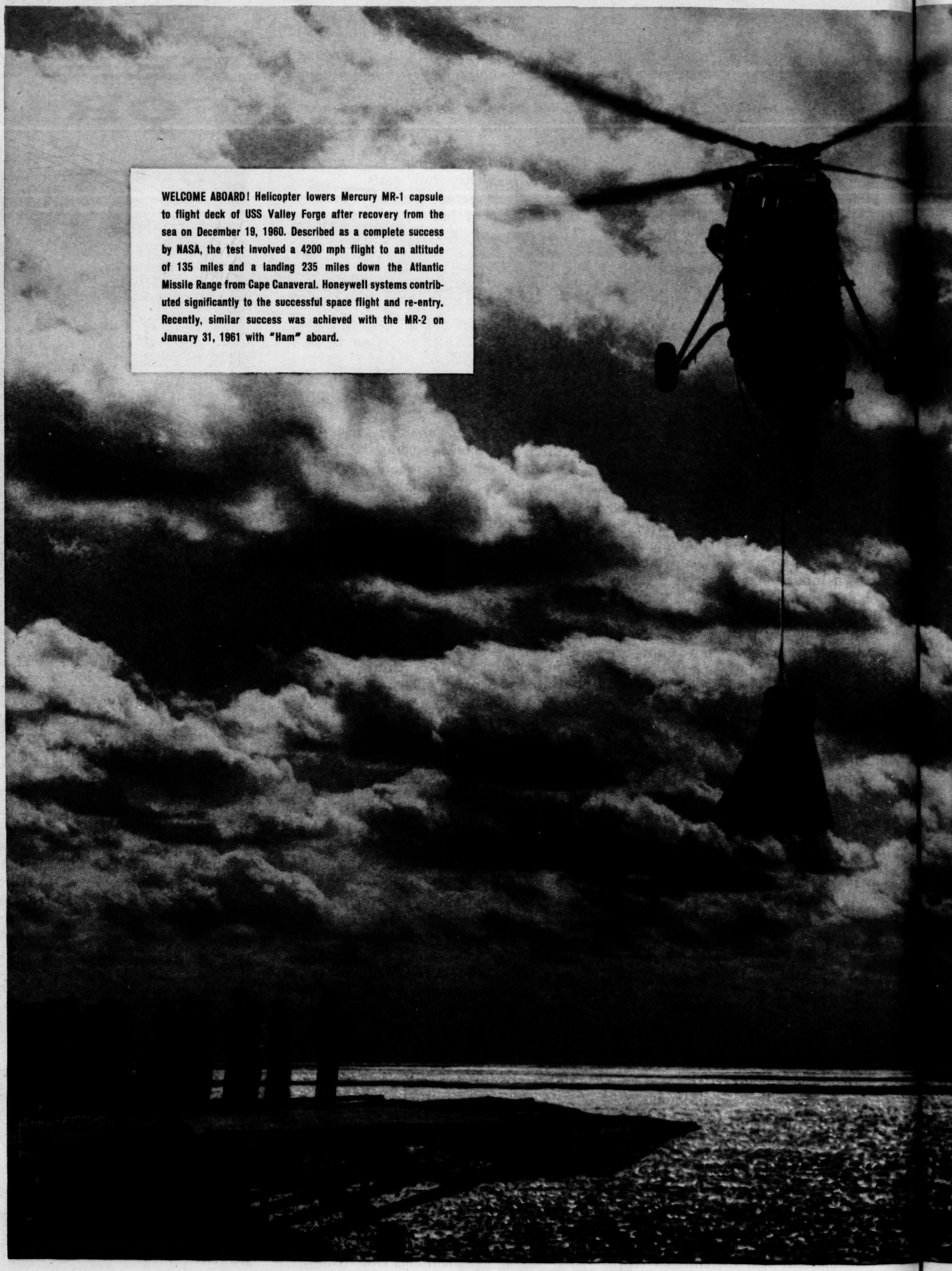


THE FENN MANUFACTURING COMPANY

Newington, Conn. Phone: MOhawk 6-2471

←CIRCLE 138 ON READER SERVICE CARD

CIRCLE 139 ON READER SERVICE CARD



WELCOME ABOARD! Helicopter lowers Mercury MR-1 capsule to flight deck of USS Valley Forge after recovery from the sea on December 19, 1960. Described as a complete success by NASA, the test involved a 4200 mph flight to an altitude of 135 miles and a landing 235 miles down the Atlantic Missile Range from Cape Canaveral. Honeywell systems contributed significantly to the successful space flight and re-entry. Recently, similar success was achieved with the MR-2 on January 31, 1961 with "Ham" aboard.

Official NASA Photo

PROJECT MERCURY: TWO STEPS FORWARD!

Honeywell's Attitude Stabilization and Control System properly sequenced the orientation, deceleration and spinning, essential to the re-entry and safe landing of the Mercury MR-1 and MR-2 ("Ham") capsules.

Project Mercury, NASA's initial manned space flight program, is rapidly nearing the stage at which an astronaut will ride the capsule. Preliminary stages of testing have resulted in refinements that will assure the astronaut's safety and comfort from take-off to touchdown. In the manned shot, just as in these successful tests, Honeywell systems are vitally involved.

Here is how Honeywell systems contributed to the success of the completed MR-1 shot shown at left. After a two minute boost from the Redstone missile, the capsule was separated. The Honeywell Attitude Stabilization and Control System damped out any initial tendency to tumble, in about five seconds, and held the capsule in the attitude of separation. During a five minute period of orientation the capsule was yawed around so that the blunt end (heat shield) was in the leading position. Also, by means of a Honeywell gyro, the capsule was oriented with the blunt end elevated 14° from a perpendicular to local vertical. Later this orientation was changed to 34°, and the retrorockets were fired for two minutes to reduce speed by 350 mph. The capsule was then aligned to a very shallow reentry angle. Upon sensing a 0.05G deceleration, the system started the capsule spinning at a rate of 10°/sec. At 21,000 feet altitude, a parachute was deployed and the control system disconnected.

This carefully programmed sequence was sensed and controlled by extreme-precision Honeywell gyros and related circuitry in the system. Functions of the system were telemetered to the ground for study in preparation for the manned capsule flight. Additional information was gained from the "Ham" shot. The astronaut will have the option of using manual controls to override the automatic system control.

The manned flight will also carry a Honeywell Attitude and Rate Indicator System which provides the astronaut with information on capsule attitude, rate of attitude change and a reference for controlling attitude. A Honeywell Earth Path Indicator will provide continuous information of the location and direction of travel in relation to the surface of the Earth. A Honeywell Humidity Indicator will keep the astronaut posted on the humidity condition.

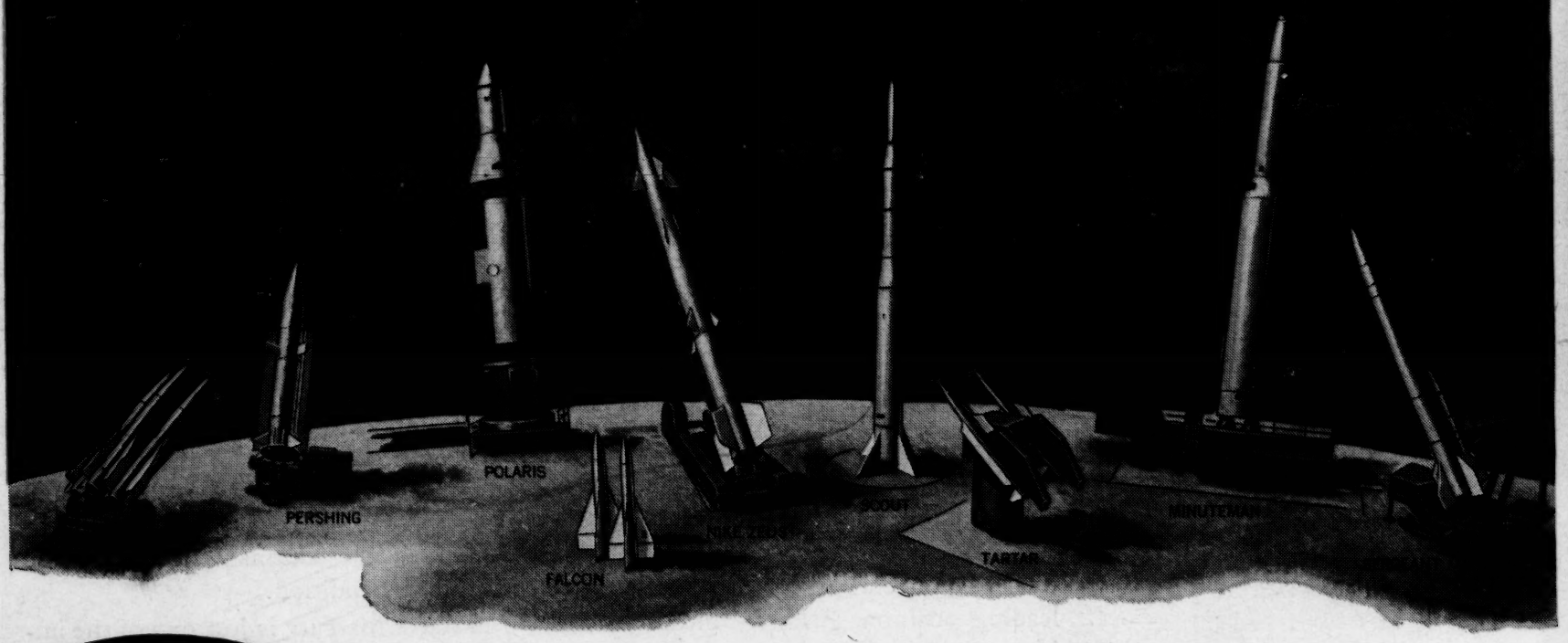
Project Mercury is just one of the important missile and space programs for which Honeywell is providing guidance, control and stabilization systems. Others include Centaur, Scout, X-15, Agena B, Thor-Delta and Polaris. Honeywell is also Prime Contractor on ASROC and Associate Prime Contractor on Dyna Soar. To learn how Honeywell can assist with systems integration and management programs, contact your nearest Honeywell representative, or write: Honeywell, Aeronautical Division, 2600 Ridgway Road, Minneapolis 13, Minnesota. *Sales and service offices in all principal cities of the world.*

Honeywell

H HONEYWELL *Military Products Group*

Engineers and Scientists:
Explore the professional opportunities at Honeywell

MORE THAN "PAPER PROMISES"....



TRONA® AMMONIUM PERCHLORATE

Has Been Qualified *in Performance* by Every Manufacturer and Program in Solid Propellant Technology

What better testimonial can there be for a solid rocket fuel oxidizer than to be performance proven on every leading solid missile in our national arsenal? TRONA Ammonium Perchlorate gives more than "paper promises"... goes further than merely meeting specifications. The past, present, and future of dependable solid propulsion stems from the contributions made by AP&CC, from the earliest development of solid materials to the drawing boards for tomorrow's space craft. By every solid fuel standard—reliability, portability, uniformity, and reproduceability—TRONA Ammonium Perchlorate is the ideal oxidizer; more than ever before the real measure of solid propellant capability.

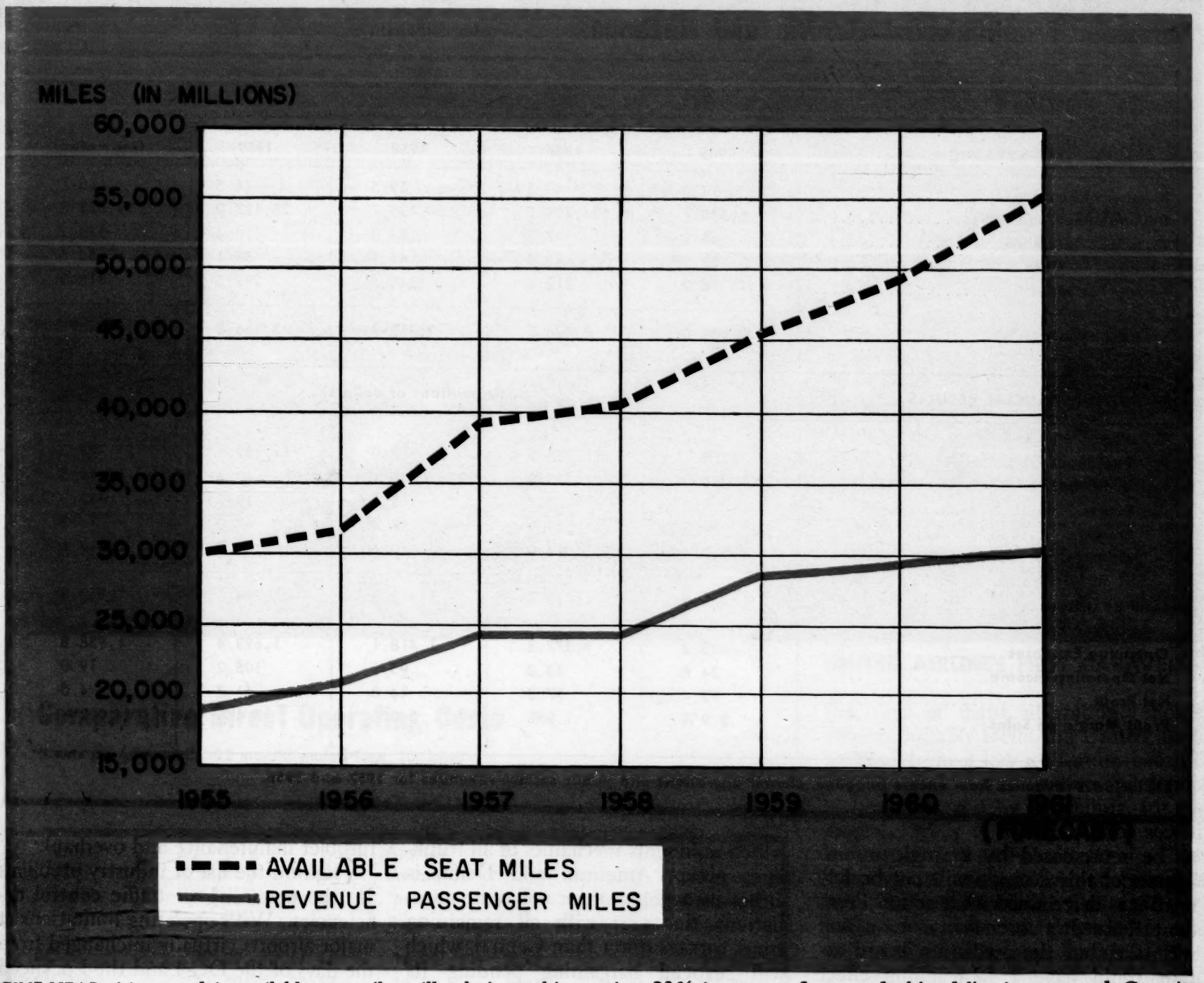
American Potash & Chemical Corporation

3000 West Sixth Street, Los Angeles 54, California • 99 Park Avenue, New York 16, New York

PRODUCERS OF: BORAX · POTASH · SODA ASH · SALT CAKE · LITHIUM · BROMINE · CHLORATES AND PERCHLORATES
MANGANESE DIOXIDE · THORIUM · YTTRIUM AND RARE EARTH CHEMICALS

142

Circle Number 142 on Reader-Service Card



FIVE-YEAR rising trend in available seat miles will culminate this year in a 23% increase as first round of jet deliveries nears end. Capacity problems trunklines will face are illustrated by the much slower rising revenue passenger mile curve. Estimate for number of available seat miles the airlines are expected to generate this year was based on the assumption that utilization of piston-engine aircraft will be cut sharply in order to prevent further load factor declines. Capacity could rise as high as 50% over last year if combined piston-turbine aircraft fleets were maintained throughout the year at normal utilization rates.

Costs, Jet Competition Squeeze Trunks

By L. L. Doty

Washington—Rapidly expanding turbojet fleets, once viewed as an antidote to all domestic trunkline ills, have triggered a competitive battle for survival that threatens to reshape the entire domestic scheduled airline industry before the end of the year.

Soaring seat capacity, estimated to rise this year as high as 23% over 1960, coupled with a disappointing 4% traffic increase predicted for 1961, has intensified the hot race for business, which already has forced one carrier—Capital—into merger, and has seriously weakened the fiscal condition of at least three other major trunklines. And the challenge of how to fill seats is just one of many the glamorous turbojet transport has brought.

Foremost among these problems is the rising cost level—strongly bolstered in its upward swing by high depreciation and amortization expenses of turbojet equipment and interest and transition costs—which continues to absorb profits. In addition, the continuing scramble for more turbojets to keep pace with competition, is severely straining the financial resources of the industry to a point where borrowing for new equipment is becoming extremely difficult, if not, in many cases, impossible.

Earlier this year, Eastern found one way to bypass the financial barrier: it will lease from the Prudential Insurance Co. 10 of the 15 Boeing 720 medium-range transports it has on order, instead of buying them direct from the manufacturer (AW Jan. 30, p. 38). The five other Boeings will be financed through cash flow.

Capital leased its jet fleet from United during pre-merger days in order to stand up against competition and Northeast leased Boeings from TWA, its potential merger mate. Other carriers may not find it so easy to devise means of augmenting their jet fleets to keep pace with competition, a position which could quickly translate profits into deficits.

High wage costs stand out this year as a major factor in airline economics. Chief labor issue stems from the decision of the National Mediation Board to classify United Air Lines' pilots and flight engineers as flight crew members

Domestic Trunklines——Traffic and Revenues (in millions)

TRAFFIC	1949	1957	1958	1959	1960 (estimated)
Number of Passengers	14.0	40.3	39.5	44.5	45.7
Revenue Passenger Miles	6,570.7	24,499.5	24,435.7	28,127.2	29,573.8
U. S. Mail Ton Miles	40.9	97.2	104.0	116.4	130.2
Express Ton Miles	27.3	42.8	45.9	53.1	55.6
Freight Ton Miles	94.2	218.4	240.5	282.5	318.3
Total Ton Miles	809.0	2,720.0	2,750.9	3,166.8	.....
FINANCIAL RESULTS			(in millions of dollars)		
Revenues					
Passenger	$378.1	$1,287.2	$1,363.0	$1,632.6	$1,774.3
U. S. Mail	45.0	33.8	36.1	40.6	44.5
Express	9.0	14.7	16.1	19.2	22.3
Freight	18.3	49.9	57.4	67.0	74.3
Other (1)	9.4	34.0	40.6	39.2	42.4
Total Revenues	459.8	1,419.6	1,513.6	1,798.6	1,957.8
Operating Expenses	435.2	1,377.6	1,418.1	1,693.4	1,938.8
Net Operating Income	24.6	42.0	95.1	105.2	19.0
Net Profit	13.4	27.0	44.8	61.7	4.0
Profit Margin on Sales	2.9%	1.9%	3.0%	3.4%	0.2%

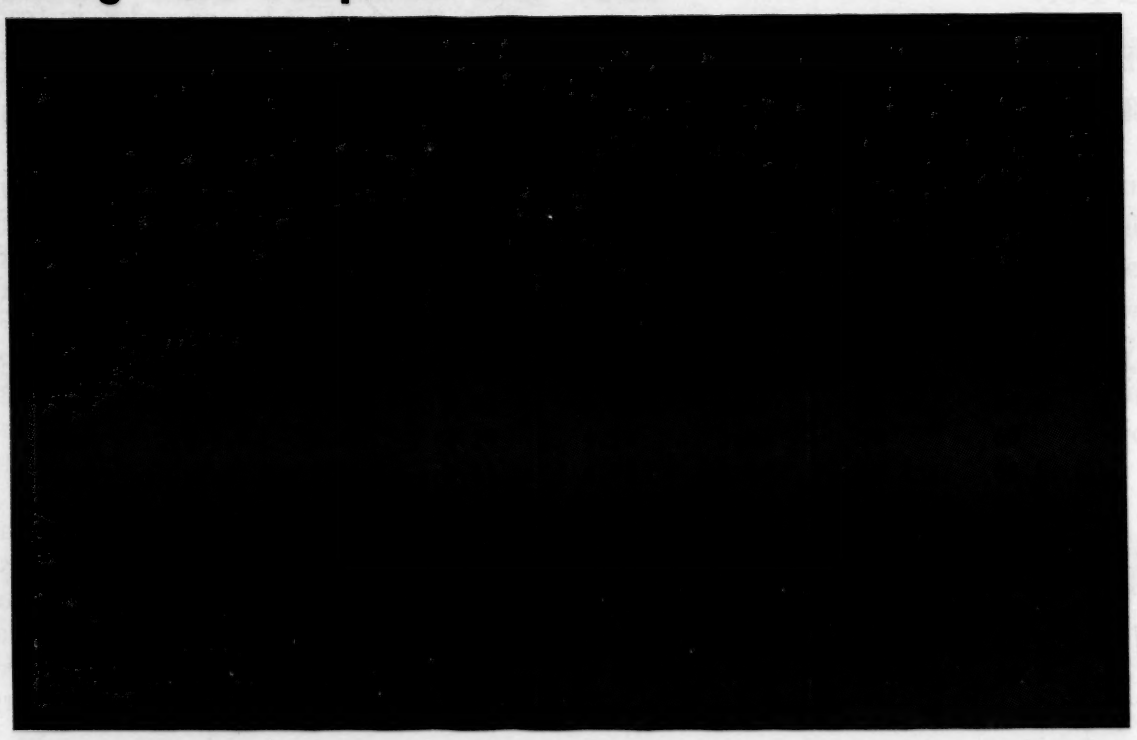
(1) Includes revenues from excess baggage, charter operations and public service revenues for 1957 and 1958.

to be represented by a single union. Impact of this decision will not be felt until it is determined what action President Kennedy's three-man commission will take, but the mediation board action could have a far-reaching effect on crew make-up, which already has undergone drastic and costly changes since the introduction of turbojet equipment.

International Assn. of Machinists, which represents mechanics of all trunklines except American and Delta, is either in negotiation or will start negotiations this year with all remaining trunk carriers other than Capital, which will suspend bargaining pending its merger with United. IAM contracts run for a period of two years and the renegotiations undoubtedly will terminate in another hike in labor costs as a direct result of the complexities of turbojet maintenance and overhaul.

High on the list of industry problems are the perennial air traffic control deficiencies. With operating limitations at major airports virtually unchanged from the days of the DC-4 and the Lockheed O49, flight delays, diversions and weather cancellations are costing operators of turbojet equipment $25-$50 million annually. Prospects for any early improvement in the air traffic control system as it is now constituted appear to be dim.

Domestic Trunkline Traffic Activity During 1960 Compared with 1959



Technical Success

From the standpoint of technical performance, the turbojet fleet has been an overwhelming success. But this success has been somewhat shielded from the traveling public's eyes by a series of spectacular accidents, air traffic control delays, structural problems of the Lockheed Electra and a safety record that ended 1960 with 1.08 fatalities per 100 million passenger miles compared with a .72 rate in 1959.

Passengers have accepted the turbojet fleets with enthusiasm ever since the aircraft were first introduced in late 1958, but this reception has merely resulted in a diversion from piston-engine aircraft rather than opening of new markets or in an expanding traffic volume, which more than one top airline official said would be the case.

Inability to dispose of piston-engine aircraft has left them either idle or at a

UNITED AIRLINES FIRST CARAVELLE

Comparative Direct Operating Costs

(Cents per plane-mile, 12 months ended Sept. 30, 1960

Domestic Trunk Lines

	Flying Operations	Direct Maintenance	Applied Maintenance Burden	Depreciation	Interchange Expense	Total Direct Operating Expense
DC-3	47.92	17.46	14.02	0.87	.....	80.54
CV-240	51.50	21.53	19.99	0.85	.....	93.80
CV-340	49.09	20.17	14.02	8.84	1.17	93.39
CV-440	48.69	19.09	10.91	17.87	.....	97.82
M-404	53.66	23.44	14.73	0.93	.....	95.32
DC-4	60.79	27.25	15.15	1.14	.....	106.55
DC-6	68.57	26.33	24.04	1.87	4.39	125.14
DC-6A (freight)	64.36	26.10	23.25	50.15	.....	163.86
DC-6B	73.28	25.02	16.65	20.21	3.02	138.48
DC-7	66.85	34.87	26.71	40.93	16.65	186.64
DC-7B	74.10	31.71	12.36	29.42	.....	148.44
DC-7C	79.74	33.49	16.95	27.45	.....	159.07
DC-7F (freight)	76.68	34.29	29.51	49.86	.....	190.36
L-049	73.26	29.39	25.57	2.61	.....	132.26
L-749	76.19	32.57	28.83	4.86	.....	144.82
L-1049	77.29	52.94	40.34	1.88	.....	174.24
L-1049C	75.20	33.93	15.78	5.40	.....	130.00
L-1049G	85.14	35.50	23.60	47.96	.....	196.96
L-1049H	112.95	42.37	31.15	39.52	.....	228.75
L-1649	87.96	52.63	42.61	73.99	.....	258.55
C-46 (freight)	41.47	17.19	12.31	13.82	.....	84.79
B-377	81.84	15.59	14.20	.....	.....	111.62
Viscount	50.06	21.87	11.94	19.95	.....	104.24
Electra	66.53	55.06	17.25	39.88	.....	179.34
B-707 & 720	99.10	35.37	16.70	27.14	0.89	179.63
DC8	89.23	38.00	28.30	41.38	2.59	201.90
CV 880	85.23	20.19	16.53	42.37	.....	165.40

low rate of flight utilization. Some carriers, notably Delta and United, have profited from a low utilization because of relatively low amortization and depreciation costs and by scheduling, for example, DC-7s in markets once served by Convair 340 or 440 aircraft at a time convenience previously unattainable with the highly-utilized Convairs.

Generally, however, grounded or seldom-used piston-engine aircraft are not making money for the airlines although many have been or are being converted to all-cargo aircraft to gain some contribution to overhead defrayal.

Passengers without question prefer the turbojet transport over all other types of equipment. Thus carriers heading for an all-jet fleet already have a strong advantage over their competitors. Here, United Air Lines has taken a lead, particularly over its prime-competitor, American Airlines, which has been operating the first quarter of this year with a fleet reductions due to its turbofan conversion program (AW Feb. 6, p. 36).

Although United will inherit 40 Vickers Viscount turboprop transports through its merger with Capital Airlines, it will be first to introduce short-range turbojet transports in the U.S. when it begins Caravelle operation this summer. This short-medium range capability will be augmented by at least 20 Boeing 727 transports within the next three years. As a result, turbojets will soon constitute the backbone of United's operations. American has made no commitments for the short-range turbojet transport as yet.

Most operators of the Lockheed Electra are agreed that the future of the

turboprop transport on major trunkline routes is limited. Western Air Lines, which patterned its future planning around the turboprop, later keyed its route expansion program in the Civil Aeronautics Board Transpacific Route Case to the turbojet. American is actively working to dispose of its 33 Electras.

A race that began two years ago to introduce combined turbojet-turboprop fleets into domestic operations has devolved into a race for all-jet fleets with American and United jockeying for first place in terms of traffic handled.

Eastern Air Lines, generally the leader in the number of passengers carried, has been submerged by a blanket of competition on its major routes that brought about a decline in 1960 in the number of passengers carried and volume of revenue passenger miles compared with 1959. TWA without the guidance of a chief executive officer and beset with indecision over fleet financing, also recorded a drop in both categories last year.

American carried 8.1 million passengers a total of 6.3 billion revenue passenger miles for a 65.3% load factor in 1960. United handled 7.6 million passengers, generated 5.4 billion revenue passenger miles and reported a 64.8% load factor in the same period.

Continental Airlines showed a decided increase in revenue passenger miles in 1960. Total jumped to 891 million from 676 million in 1959. Delta Air Lines reported 1.5 billion in 1959 compared with 1.8 billion last year. Delta's load factor moved from 57% to 59.3% in the same periods.

Braniff generated 1 billion revenue passenger miles in 1960 contrasted with 941 million in 1959. Both Capital and National reported a revenue passenger mile decline in 1960 from levels reached in 1959. Western's revenue passenger miles totaled 899 million in 1959 compared with 951 million recorded last year.

Domestic Trunk Airline Load Factors

	1960	1959
American	65.3%	70.2%
Braniff	56.9	58.1
Capital	53.0	58.4
Continental	50.3	54.8
Delta	59.3	57.1
Eastern	52.1	50.7
National	53.8	55
Northeast	51.6	50.3
Northwest	55.3	55.6
Trans World	63.9	70.5
United	64.8	66.8
Western	57.8	60.5

Problem for CAB

If revenue passenger mile volume continues to lag throughout 1961, the excess capacity menace will pose an immediate problem to the Civil Aeronautics Board that will call for prompt and, perhaps, drastic action before the year is out, if the industry, as it is now constituted, is to remain financially sound. With the exception of Robert T. Murphy, newest member of the Board (AW Feb. 13, p. 40) who is still an unknown with respect to his philosophy on airline operations, all Board members are known to favor mergers if necessary to the health of the industry and to oppose any revival of trunkline subsidies.

In view of the equipment now in use and that which is to be delivered in 1961, available seat miles in 1961 will increase by a startling 23%. If revenue passenger miles climb only 4%, this large volume of available seat miles would give the trunklines an approximate 49.6% load factor, which would drive the industry deep into the red.

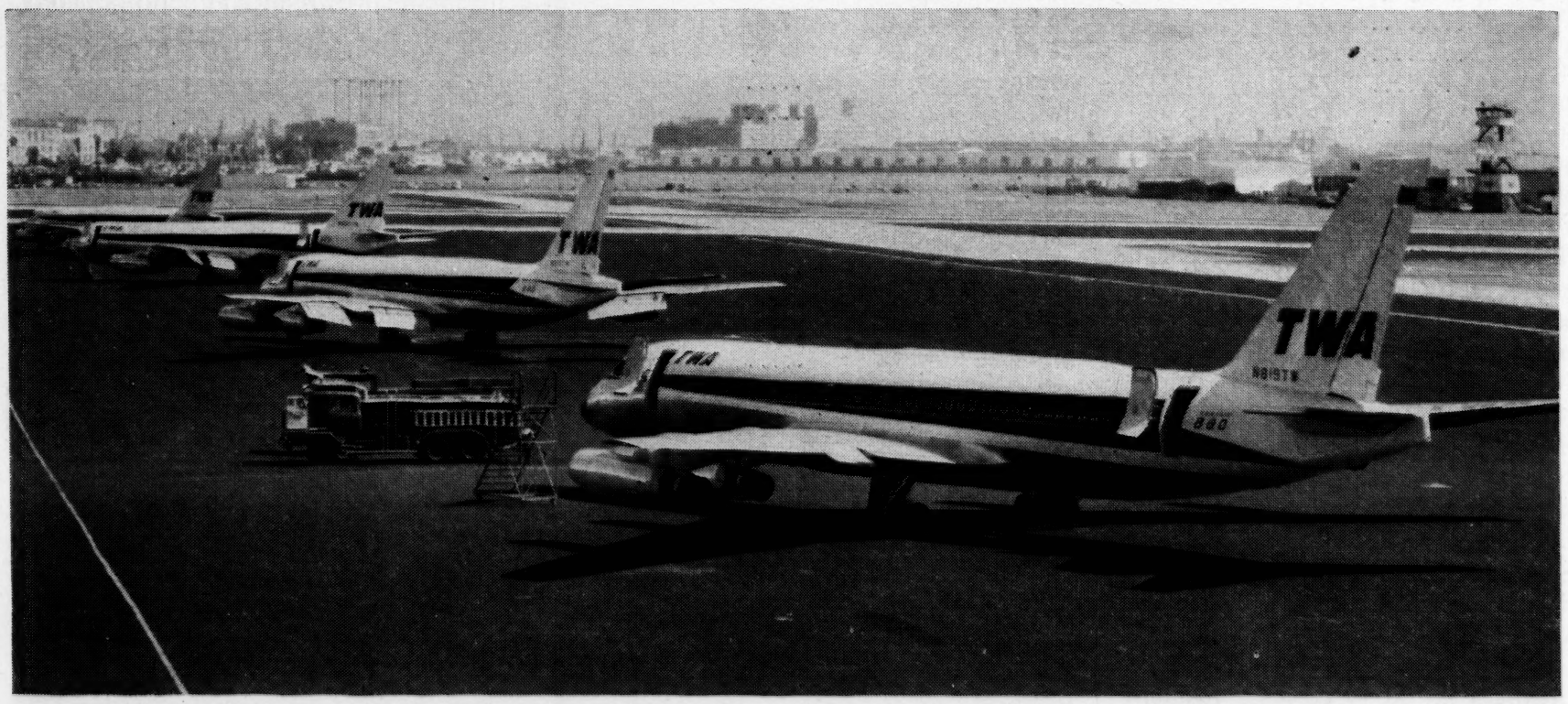
Since a 10% increase in available seat miles would give the carriers a 56% load factor—again assuming a 4% traffic increase, it seems only logical to speculate that the industry will establish some control over seat miles to hold the rise to the 10% area. AVIATION WEEK's forecast of available seat miles is based on this theory (see chart).

The real danger lies in the fact that the 56% load factor is an average, meaning that, while some carriers will pull above this mark, others may fall well below it to precarious levels. These will be the airlines interested in mergers. This year the load factor element will be an important measuring figure in judging individual airlines.

The 4% traffic rise is based on the assumption that the expected general economic recovery may not occur until the middle of the second half of the year. Earlier recovery might bring about a 6-8% increase for the year despite the poor traffic showing in January and February.

Key to the Board's future role in industry affairs is the new chairman, Alan S. Boyd, who, at 38, is the youngest person ever to hold this post. Boyd can be expected to exercise stronger leadership on the Board than some of his predecessors. He will show no tolerance for weak managements and has no intention of nursing the industry back to health through dictatorial methods but will expect airline managements to develop imaginative means of solving their own financial problems.

He is a strong advocate of competition, contending that regulatory control of the industry is based on the principle of competition. On the other hand, he



TWA's CONVAIR 880s on the ramp at the factory awaiting delivery after completion of the carrier's financing.

AMERICAN AIRLINES' BOEING 720B

deplores an overabundance of competition as, for example, positioning of nine major airlines back-to-back on the New York-Washington route.

He will fight for more stringency in the award of routes in the future and will show a strong interest in the realignment or redistribution of routes as one practical way to keep the industry out of trouble. He is on record as saying that it is "possible that a series of mergers might be beneficial . . . " but believes that the Board must prevent mergers from destroying competition.

The Board's antipathy toward subsidy is generally supported by the larger trunklines. American's President, C. R. Smith, has asked for a repeal of the subsidy provisions of the Federal Aviation Act of 1958 and has termed subsidy "not a cure for the disease afflicting the industry, but a disease itself." In any event, the CAB order which called for an investigation to determine whether Capital should be dismembered (AW May 25, p. 43) following the carrier's petition for subsidy, should discourage others from seeking relief through subsidy.

Boyd is very likely to frown upon such in-flight frills as free champagne or flowers as a means of expanding travel markets. His theory is that passengers are now too sophisticated to think that such favors are being bestowed without extra cost and that, generally, they would prefer lower fares to inconsequential giveaways. Boyd will, of course, receive staunch support in his stand on lower fares from Member Joseph Minetti.

The rate issue is far from settled and could be a major factor in the economy of the airlines during 1961. Eastern has asked the U.S. Court of Appeals to review the Board's decision in the General Passenger Fare Investigation and order more comprehensive action (AW Feb. 6, p. 38). The 5% increase granted by the Board last year (AW June 6, p. 41) was to have given the airlines an opportunity to earn over a long term period the 10.5% rate of return the Board agreed was reasonable and the Board estimated it would increase profits by $84 million annually. The estimated $4 million net profit the industry squeezed out in 1960 (AW Jan. 2, p. 27) is a rude suggestion as to how far off the Board's projection was initially.

Growth of Coach Traffic in 1960 Compared With First-class Traffic

	Revenue Passenger Miles (in billions)		Available Seat Miles (in billions)		Load Factor	
	Coach	First-class	Coach	First-class	Coach	First-class
January	1.07	1.34	1.73	2.31	61.78%	57.92%
February	0.93	1.19	1.61	2.18	58.06	54.59
March	1.01	1.26	1.75	2.32	57.74	54.45
April	1.16	1.33	1.79	2.28	65.14	58.11
May	1.13	1.30	1.87	2.25	60.60	57.59
June	1.35	1.35	1.86	2.19	72.57	61.76
July	1.46	1.22	2.09	2.25	70.18	54.33
August	1.48	1.24	2.13	2.27	69.62	54.69
September	1.29	1.25	1.96	2.14	65.44	58.19
October	1.21	1.27	1.98	2.21	61.04	57.36
November	1.05	1.07	1.88	2.02	55.61	53.25
December	1.23	1.04	2.04	2.04	60.38	51.04

Coach Traffic

Tied-in with the rate issue is the narrowing gap between coach and first-class traffic, with all signs indicating that, in 1961, coach will be the dominate type of traffic carried by the airlines, a transformation that will cut deep into revenues as it becomes more pronounced. Shorter flying times of the turbojets are major contributing factors to the general switch to coach.

Still an unknown factor in determining the effect of turbojet aircraft on airline incomes is the part Najeeb Halaby, new Federal Aviation Administrator, will play toward unraveling the air traffic control muddle. The patchwork system now in use has been substantially improved since the FAA was established in 1958, but a modern system, designed to cope with high-speed performance characteristics of the turbojets, is still in the experimental stage.

Halaby will put increasing stress on airways modernization programs and will enlist the aid of scientists to accelerate his research and development efforts.

Halaby will tend to rely more heavily on the technician rather than the administrator in regrouping his staff. He will delegate responsibility to a greater degree than his predecessor, E. R. Quesada, was inclined to do.

He will pursue a strict enforcement program but will strive for the cooperative support of pilots and pilot groups to avoid the personal feuds that so engrossed Quesada. He may find some difficulty in coordinating civil air traffic control issues with military flying activi-

Total Traffic on U. S. Common Carriers

	1959 (ACTUAL)		1960 (EST.)	
	Passenger-Miles (billions)	Percent of total	Passenger-Miles (billions)	Percent of total
Air	25.3	43.0	30.7	49.2
Rail	18.5	31.4	17.0	27.2
Bus	15.1	25.6	14.7	23.6
Total	58.9	100.0	62.4	100.0

Consumer price index for 1/9/59 (on basis of ten month) 206.3
Public Transportation " " 238.8

Domestic Trunkline Orders for Turbine Aircraft

Airline	Aircraft	Number Delivered	On Order For Delivery In: 1961	1962	1963	Total
American Airlines	Boeing 707	25	1	....	....	26
	Boeing 720	10	15	....	....	25
	Convair 600	....	15	10	....	25
	Convair 990	....	....	10	....	10
	Lockheed Electra	35	....	....	....	35
Braniff Airways	Boeing 707	4	1	....	....	5
	Boeing 720	....	3	....	....	3
	Lockheed Electra	9	....	....	....	9
Capital Airlines	Vickers Viscount 745	61	....	....	....	61
Continental Air Lines	Boeing 707	5	....	....	....	5
	Vickers Viscount 812	15	....	....	....	15
Delta Air Lines	Douglas DC-8	6	....	....	....	6
	Convair 880	10	3	....	....	13
Eastern Air Lines	Boeing 720	....	15	....	....	15
	Boeing 727	....	....	....	40	40
	Douglas DC-8	11	5	....	....	16
	Lockheed Electra	40	....	....	....	40
National Airlines	Douglas DC-8	3	....	....	....	3
	Lockheed Electra	14	1	....	....	15
Northeast Airlines	Vickers Viscount 745	10	....	....	....	10
	Convair 880	6*	....	....	....	6
Northwest Airlines	Douglas DC-8	5	....	....	....	5
	Lockheed Electra	10	8	....	....	18
Trans World Airlines	Boeing 707	15	....	....	....	15
	Boeing 707-331	12	....	....	....	12
	Convair 880	15	5	....	....	20
United Air Lines	Boeing 720	16	2	11	....	29
	Boeing 727	....	....	....	20	20
	Caravelle	32	19	1	....	52
Western Air Lines	Boeing 720	....	4	....	....	4
	Boeing 707	2*	....	....	....	2
	Lockheed Electra	6	6	....	....	12
Total		377	103	32	60	572

* leased from manufacturer

ties, but, when he accepted the FAA post, he made certain that he would have the President's ear on civil aviation matters which will provide him with a powerful protection against military pressures for more airspace.

Gross revenues for the domestic trunklines in 1960 are now estimated at $2 billion compared with $1.8 in 1959, a 9% increase. Total expenses rose $1.7 billion in 1959 to $1.9 billion last year, a 14% increase. Net profit after taxes was $4 million, a 0.2% profit margin on revenues and a 3.4% rate of return on invested capital.

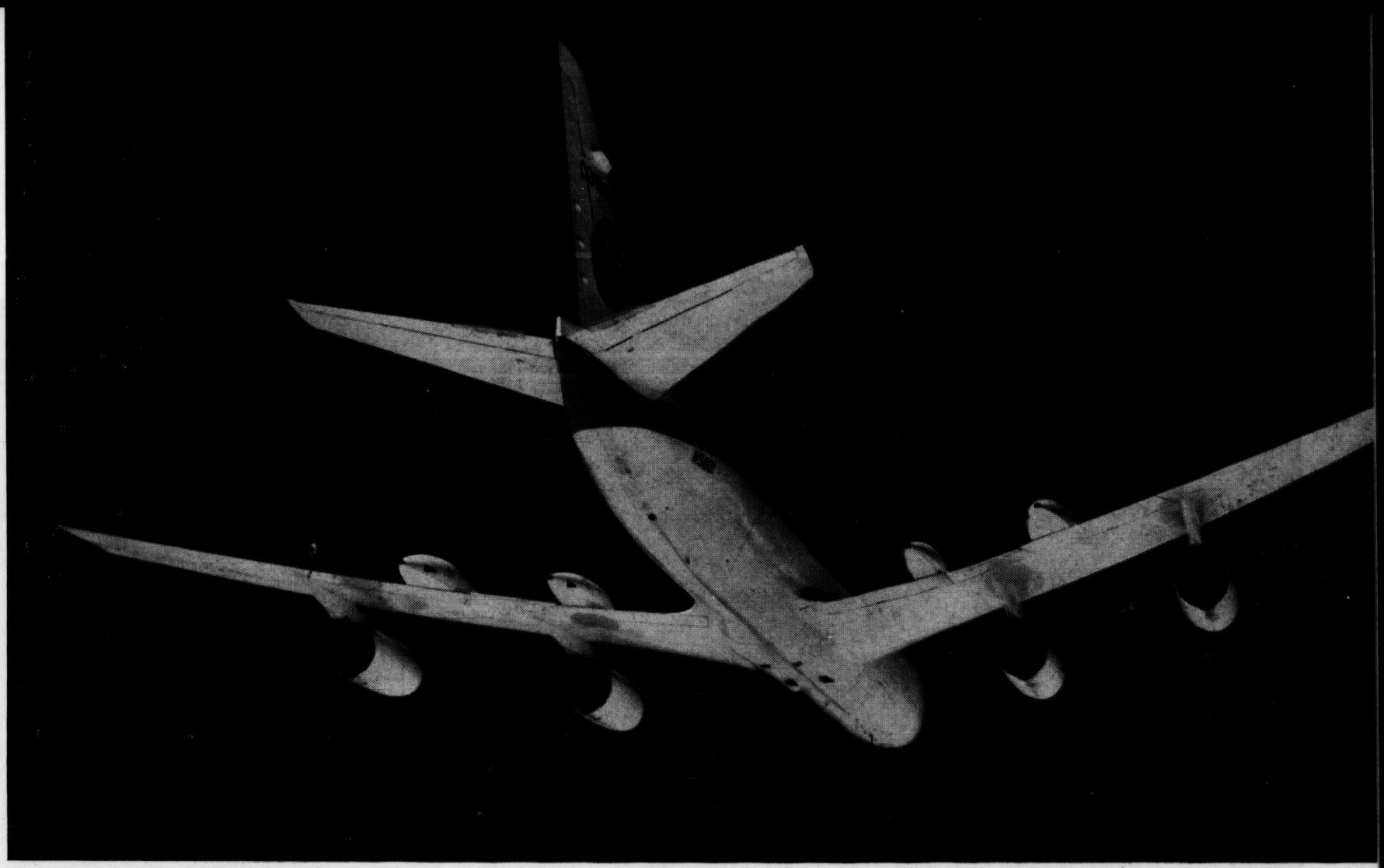
Net earnings for the industry were $61.7 million in 1959, $44.8 million in 1958 and $27 million in 1957. The industry's slight 4% increase in revenue passenger miles, compared with a 15% increase in 1959, does not appear to be too unsatisfactory when compared with results of surface competitors. Railroads estimated they operated 3% fewer revenue passenger miles in 1960 and intercity buses estimated they stayed at 1959's level.

As of December, 1960, the domestic airlines had taken delivery on 278 turboprop aircraft and 207 turbojet transports. On order for delivery between 1961 and 1963 are 28 turboprop and 193 turbojet aircraft, of which more than 100 will be delivered this year. The industry will have invested approximately $3.5 billion in the new equipment after all deliveries of planes now on order have been made.

To minimize the noise problem $50 million has been spent by aircraft manufacturers in developing noise suppressors and the airlines have equipped their turbojet fleets with them at a cost of another $50 million. Extra fuel and other operating costs, stemming from the suppressors, reach $20 million annually.

The year 1961 promises to be a crucial period for many airlines, particularly those faced with the competition of high-density turbojet schedules. Even if the present traffic trend should undergo an unexpected upward climb to compare with or surpass 1959's record, it is unlikely that some small carriers can withstand the onslaught of available jet seat miles being generated by the large or financially strong trunklines.

Assuming that subsidy has all but been eliminated insofar as trunk carriers are concerned, the merger route appears to be the most logical means of compressing the industry to the size of its market as it is now projected. Realignment of routes would mean merely a redistribution of available passenger traffic, which, if the growth factor remains stagnant, would make the poor less poor but would make no one rich. Some basic change in the industry now appears to be inevitable.



CONVAIR 990 TURBOFAN TRANSPORT

U.S. Traffic Share Continues to Decline

By Glenn Garrison

A critical year looms for U.S. flag airlines faced with competition of new foreign jet fleets and new carriers, bilateral battles, mounting disputes in the International Air Transport Assn., and possible basic revision of this country's international aviation policy.

Last year marked the first widespread operation of jets on routes between the U.S. and other countries. The big switch from the piston era is now well along and the problem of filling the expensive, high capacity jets is squarely before the carriers.

Traffic carried by the U.S. flag lines generally showed increases for 1960, but their share of the total continued to decline.

The year 1960 began significantly with an emergency IATA meeting in Paris, a last-minute measure to resolve a previous deadlock that had left open the fare structures for several areas including the North Atlantic. Further controversy erupted at the organization's general meeting last September in Copenhagen where small airlines rebelled against alleged domination by IATA's executive committee.

Cargo Dispute

Last month another split in IATA resulted in the ending of a traffic conference without agreement on a new cargo rate structure. An open rate cargo situation seemed in prospect for the North Atlantic.

Relations between the U.S. and several foreign governments in the realm of air rights were strained by controversies during 1960, and there seemed no early prospect of resolution. Examples were the Dutch, pressing for rights to the West Coast; Scandinavia, sparring with the U.S. over interpretation of Fifth Freedom rights and capacity restrictions, and India, pushing for new routes to the U.S. and the maintenance of capacity restriction on U.S. carriers.

The matter of capacity restrictions emerged as a major controversy. Pressure mounted on the U.S. for tighter control of international passengers.

A highly important development in U.S. international aviation was former President Eisenhower's decision, announced a day before he left office, which in effect left the Pacific route structure almost unchanged. This decision followed several twists and turns of policy in the long, bitterly fought transpacific route case.

Involved in this decision is a basic change in U.S. policy calling for bilateral pacts to be negotiated on a diplomatic rather than an economic basis. A review of the question is expected by the Kennedy Administration.

Latin Rates

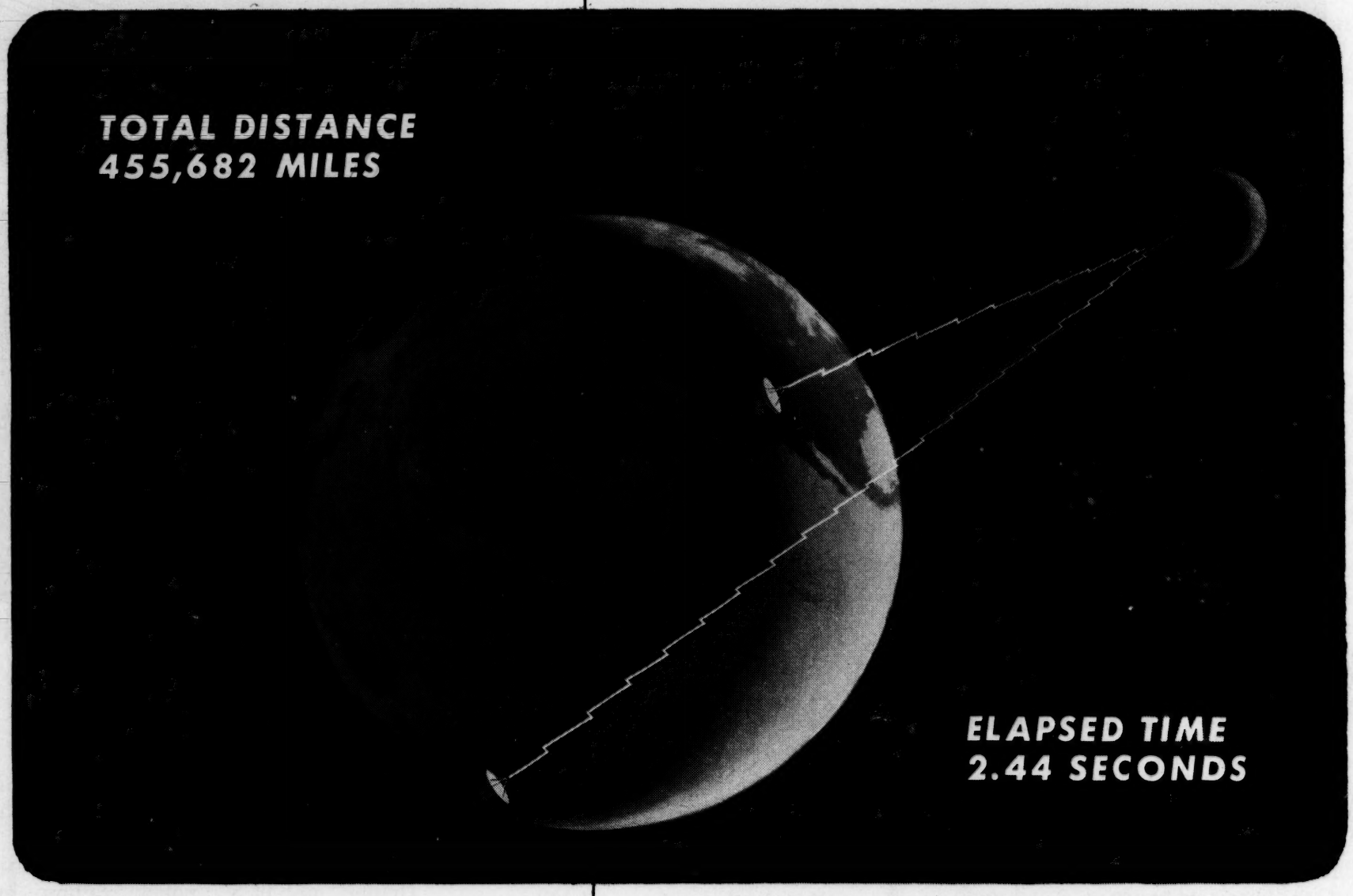
Another area of controversy is Latin America, where rate levels and capacity limits are in continuing dispute despite efforts to bring some balance to South American air transportation.

U.S. flag carriers were hit by flight engineer strikes which crippled service last month for Trans World Airlines and Pan American World Airways. Northwest Orient Airlines' jet operations were curtailed by a flight engineer strike which began last fall and was still continuing late last month.

Pan American's systemwide traffic rose from 3,122,767 passengers in 1959 to 3,381,150 in 1960. Passenger miles increased from 4,232,000,000 to 4,833,000,000 for the year. Strong increases in passenger traffic were recorded for the Atlantic and Pacific sectors of Pan Am's routes, but Latin American traffic declined from 1,436,000 passengers in 1959 to 1,264,000 passengers in 1960. One reason: the fall-off in traffic to Cuba.

Notable Achievements at JPL

MOON BOUNCE... a collaborative project of the National Aeronautics and Space Administration, the Jet Propulsion Laboratory, and the Australian Ministry of Supply to link two continents by radio signals bounced off the Moon



On February 10, 1961, California and Australia were linked in the first international space communication experiment that bounced voice messages between the two points via the Moon. The words were beamed at the Moon from the Jet Propulsion Laboratory transmitter at Goldstone, California to the receiver at Woomera, Australia.

Principals in the conversation were Dr. Hugh L. Dryden, NASA Deputy Director, whose voice was relayed from Washington by telephone; Dr. Lee DuBridge, President of California Institute of Technology, who spoke directly from Goldstone; and Alan Hulme, Australian Minister of Supply at Woomera.

The occasion tested the new Australian station, the second of three Deep Space Instrumentation stations developed and directed for the National Aeronautics and Space Administration by the Jet Propulsion Laboratory.

CAREER OPPORTUNITIES AT JPL
IN THESE FIELDS – NOW

Electronic Engineers

. . . for component and system design of deep space communications, instrumentation, and automatic control equipments.

. . . for microwave and RF solid state circuit design and flight evaluation.

. . . for project management assignment on advanced development and contracted effort in space communications.

Physicists

. . . for analysis in communications theory, orbital mechanics, guidance and control, and systems performance.

. . . for analysis of digital communication and control systems; real-time digital computer and closed-loop systems.

. . . for research and development of servo and control mechanisms for large ground based and spacecraft antenna systems.

•

Other opportunities exist for electronic engineers and physicists in many areas at JPL which has been assigned the responsibility for the nation's Lunar, Planetary and Interplanetary unmanned exploration programs.

CALIFORNIA INSTITUTE OF TECHNOLOGY

JET PROPULSION LABORATORY

PASADENA, CALIFORNIA

Pan Am, ahead with jets of all but one international carrier, completed two full years of jet operation last year. Its jet fleet has grown to six Boeing 707-120s, 23 707-320s, and 18 Douglas DC-8s. As an example of the effect of the new competitive jet fleets, Pan Am's passenger load factor on the North Atlantic was down from 81% in 1959 to 69% last year.

TWA began jet operation on its international routes in late 1959, and the full impact was evident last year. The carrier's international traffic climbed 42% to 347,921 passengers. Seat miles increased 57% to 1,765,000, and passenger miles 55% to 1,039,220,000. TWA flew 90% of its international passenger miles in jets last year. It operates eight 707-331s in the service. On the North Atlantic, capacity rose 71% and passenger traffic 67%.

Panagra joined the jet operators last year, introducing DC-8 service to South America during the summer. Passenger traffic was up 6% for the year and cargo rose 13%. Weekly DC-7F all-cargo service to South America replaced DC-6A service. Passenger miles reached a total of 198,327,000. A factor in Panagra's traffic was a new excursion fare plan, with reductions up to 35% for some services in South America.

Braniff International Airways introduced Boeing 707-220 flights to Latin America, increasing its available seat miles by 36% to 241,914,000. Traffic kept pace with the increase, the revenue passenger mile total climbing 41% to 128,432,000. Braniff now offers jet service to six Latin American cities in Panama, Peru, Argentina, Brazil and Colombia. New service to Mexico City through San Antonio was inaugurated in November, after signing of a bilateral agreement between the U. S. and Mexico. Lockheed Electra turboprops are used in this service.

Cuban Problem

Continuing political unrest in the Caribbean was cited by Delta Air Lines as the reason for a cutback last year in service to the area. On its Caribbean routes, Delta carried 25,573 passengers in 1960, down from 47,651 in 1959, and continuing a decline over a period of several years. Revenue passenger miles for 1960 were down from 60,022,-261 to 38,280,857. International load factor was down from 48.5% to 42.4%. A new Caribbean service—to Aruba—was introduced early this year. Delta operates DC-7s in its international service. Convair 880 and DC-8 services have been introduced domestically, but no definite date has been set for jet service in the Caribbean.

Eastern Air Lines systemwide traffic was down for the year. Boardings at Mexico City declined 5.8% to 23,045 passengers, and Montreal traffic was down slightly. Other international routes showed gains. Largest was San Juan, Puerto Rico, with a 23.9% increase to 201,197 passenger boardings. Bermuda boardings were up 10.5% to 23,472. Eastern began jet service to the Caribbean and in December started DC-8 service on the non-stop run between New York and Mexico City. Eastern had high hopes for increased Mexico business, with coach service being offered for the first time with the introduction of jets. This was made possible by an agreement with Aeronaves de Mexico under which the Mexican airline bought a DC-8 from Eastern's position in the production line. The Mexican jet was lost not long after delivery in a takeoff accident at New York International Airport.

American Airlines introduced the Boeing 720 last October on its New York-Toronto route, and planned to inaugurate its first jet service to Mexico with turbofan 707s—707-123Bs and 720Bs—this month. On the routes to Mexico City, American carried 111,272 passengers in 1960, down from 115,000 passengers in 1959. Revenue passenger miles on the route declined from 118,-000,000 to 114,303,000. American's DC-7 service to Mexico from Chicago had been in competition with Comet 4 jet equipment flown by CMA Mexicana de Aviacion.

Tokyo Service

Northwest began DC-8 service to Tokyo last July and prior to the strike was operating four jet flights a week on the route and DC-7C equipment on other days. A new service was begun from New York direct to Anchorage and on to Tokyo.

U. S. flag carriers handled 55% of air passengers traveling between the U. S. and foreign countries in the year ending June 30, 1960.

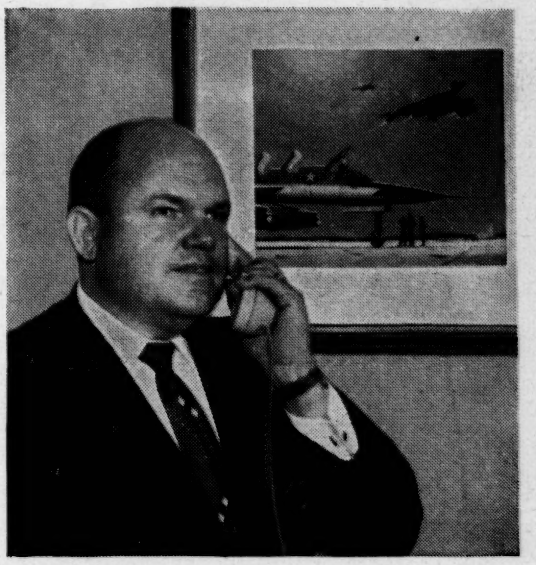
This continued the decline of the U. S. share of this traffic. The 1959 percentage was 58%. Passengers arriving and departing the U. S. by air during the period totaled 4,576,425, an increase of 13% (excluding Canadian travel over land borders).

British flag carriers handled 499,207 of the passengers, an increase of 48%. Cuban flag traffic totaled 223,150 passengers during the period; Mexican flag, 206,775; Netherlands flag, 190,035; French flag, 138,449; and Scandinavian flag, 130,160. These were the highest totals.

Air traffic between Europe and the U. S. accounted for 1,748,378 of the passenger total. New York was by far the largest-volume gateway in the U. S., with 952,564 departures during the period and 1,019,886 arrivals.

"National Defense must not wait

so we use Delta Air Freight"



Convair, Ft. Worth, Texas, uses Delta Air Freight to help meet production deadlines and testing schedules for the B-58, America's first supersonic bomber.

"Every minute test planes are grounded, our national defense program is affected," says Sam Keith, Traffic Manager. "Delta Air Freight plays a vital part in the B-58 production and testing program, by reducing the transit time for high-priority material between our Ft. Worth plant and distant test sites."

Profit from Delta's BIG PLUS

Delta operates all-cargo flights and in addition carries freight on every passenger flight, including Jets. All-Cargo flights serve Atlanta • Chicago • Charlotte • Dallas • Houston • Memphis • Miami • New York • New Orleans • Orlando • Philadelphia.

Delta AIR LINES AIR FREIGHT DOOR-TO-DOOR

GENERAL OFFICES: ATLANTA AIRPORT, ATLANTA, GA.

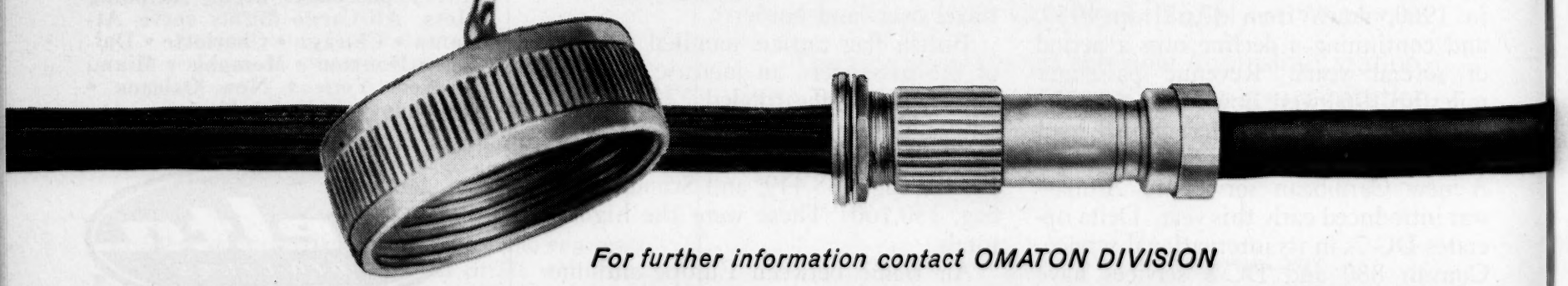
WEATHER EXTREMES ... no problem !

Water, mud, ice, snow, heat and humidity ... weather extremes are no problem with the '891' series plugs and receptacles—both HYFEN-TYPE and SOLDER-TYPE. Present early warning radar systems and firing systems prove outstanding performance—efficiency and dependability in any climate.

AQUALOK™ PLUGS AND RECEPTACLES

SOLDER-TYPE—Available in 22, 28, and 32 shell sizes with many insert configurations tooled for production. Shell, insert, and contact materials selected for excellent performance characteristics.

HYFEN-TYPE—Single conductor, miniature coax, and standard coax contacts—all crimp-type, snap-locked and individually removable—are available in 22, 28, and 32 shell sizes. Insert configurations available for power applications.



For further information contact OMATON DIVISION

BURNDY

61-10

NORWALK, CONNECT. BICC-BURNDY Ltd. Prescot, Lancs., England In Europe: Antwerp, Belgium TORONTO, CANADA

Circle Number 154 on Reader-Service Card

U.S. Local Service Airlines

SELECTED OPERATING STATISTICS YEAR 1960

	Rev. Plane Miles (000)	Rev. Passenger Miles (000)	Passengers		Average Passenger Load	Passenger Load Factor (%)	Total Rev. Ton Miles (000)	Ton Mile Util. (000)	Ave. Rev. Load (Tons)	Performance Factor (%)	Revenue Hours	Off-On Speed	No. of Departures	Ave. Length of Hop (Miles)	Daily Aircraft Utilization
			Originating	Enplaned											
Allegheny	8,531	131,657	670,111	680,986	15.4	42.5	13,655	43.1	1.60	93.0	52,401	174.3	86,762	98.3	5:04
Bonanza	4,678	65,155	261,876	266,041	13.9	40.1	6,498	41.2	1.39	99.1	24,159	189.9	35,923	130.2	4:51
Central	4,029	33,007	168,863	172,537	8.2	39.2	3,456	35.7	0.86	98.4	27,483	146.6	50,163	80.3	5:00
Frontier	9,353	90,028	338,189	389,771	9.6	38.8	9,886	43.1	1.06	98.5	60,014	156.4	93,198	100.4	5:30
Lake Central	3,693	35,974	226,936	231,572	9.7	38.5	3,736	42.1	1.01	96.1	26,584	144.2	52,382	70.5	6:04
Mohawk	6,391	119,409	590,162	641,079	18.7	45.5	12,006	42.4	1.88	95.2	39,428	163.8	60,474	105.7	5:36
North Central	14,499	171,732	967,210	1,035,076	11.8	43.6	18,206	44.9	1.26	97.8	98,785	148.1	175,415	82.7	7:14
Ozark	9,072	99,971	563,184	572,348	11.0	40.6	10,444	44.4	1.15	97.0	61,031	151.9	102,668	88.4	6:12
Pacific	6,653	114,810	499,395	516,539	17.3	50.5	11,307	45.7	1.70	98.2	37,476	177.5	62,159	107.0	4:22
Piedmont	7,275	97,048	457,123	500,564	13.3	45.3	9,880	46.7	1.36	97.2	44,879	159.4	84,231	86.4	4:54
Southern	5,669	46,765	256,947	260,760	8.2	31.7	4,953	33.6	0.87	96.3	39,107	145.0	65,037	87.2	4:47
Trans-Texas	8,110	72,035	306,885	322,921	8.9	38.7	7,783	40.1	0.96	97.9	51,482	158.4	85,862	94.5	5:38
West Coast	6,839	93,188	389,077	465,863	13.6	44.6	9,364	44.8	1.37	97.1	43,282	160.9	74,545	91.7	5:55
Total-Average	94,792	1,170,779	5,695,958	6,056,057	12.4	42.3	121,174	42.9	1.28	97.0	606,111	156.4	1,028,819	92.1	5:33

Source: Ray and Ray

Local Carriers Win New Subsidy Formula

By Robert H. Cook

Washington—Local service airlines are confident of justifying their subsidy needs before Congress this year on the strength of industry research studies emphasizing the value of their services and Civil Aeronautics Board adoption of a new subsidy payment formula designed to keep pace with the industry's growth rate.

Continued expansion of the carriers' route and equipment growth will be at a slower rate this year, the airlines point out, since nearly half of the local service DC-3 aircraft have been replaced by more modern aircraft and eight of the regional area route cases have been decided by CAB and awarded to the carriers.

While some operators have not undertaken re-equipment plans or been awarded new routes, most of the local service airlines have, and many will experience a lower subsidy need as routes are developed and equipment integrated into their fleets, the industry believes.

Local carriers are particularly encouraged by CAB approval last year of a 9-12.75% rate of return on investment and the Board's new class mail rate subsidy formula, scheduled to go into effect next month.

While the airlines are not in complete agreement with all details of the new rates, they feel that application of it with the subsidy formula will give them their first opportunity for higher earnings to enable them to attract equity or debt capital.

Early indications are that the Board's actions on rate of return and subsidy may earn local service airline securities a new stature with investors. One investment survey letter termed local service securities an "excellent opportunity" for gain, estimating that their common stock and convertible debentures could double or triple in value between 1963 and 1965. Prior Board attempts to aid the airlines by such measures as the guaranteed loan, permitting retention of capital gains and permanent certification "merely scratched the surface," the letter noted, whereas its action on the rate of return and class mail rate subsidy formula indicated the Board "has at last faced up to the issue."

Operating Figures

Reflecting the industry's extensive route and equipment growth, and the subsidy necessary to support it, are these preliminary estimates for 1960:

• **Net operating revenues** increased by 28% from the 1959 total of $112.9 million to a new high of $142.9 million.

• **Total operating expenses** of $144.8 million continue to outstrip revenues for a 19% gain over the 1959 figure of $121.2 million.

• **Net operating loss** for the industry was $1.9 million, compared with a loss of $1.3 million in the previous year.

• **Mail and subsidy payments** increased more than 21% to reach $52.5 million in 1960 as compared with $41.1 million in 1959. The latter figure represents a 17% increase over that of the previous year.

• **Breakeven need,** the difference between non-mail revenue and operating expenses, increased $12 million over 1959 to $54.4 million.

• **Load factor average** continued a three-year decline and dropped to an industry average of 42.3% compared with $44.9% for 1959 and 46.3% in 1958.

While the industry will continue to expand geographically this year, many observers see a gradual change as the airlines place a greater emphasis on the removal of costly operating restrictions on their existing route systems. Increasing CAB emphasis on the deletion of many unprofitable local service points, under the Board's use-it-or-lose-it policy, will accelerate this process, the carriers feel.

Concern over the industry's mounting subsidy bill was expressed last year in two special reports compiled for the Association of Local Transport Airlines, reports which suggested several methods for reducing the over-all sub-

TRANS-CANADA AIRLINES PHOTO

PAYMOVER®—Choice of the World's Leading Airlines

Air France
American Airlines
Braniff International Airways
British Overseas Airways Corporation
Capital Airlines
Continental Air Lines
Eastern Air Lines
Flying Tiger Line
Japan Air Lines
Lufthansa-German Airlines
Israel Airlines

The Frank G. Hough Co. is the only manufacturer to successfully design, produce and deliver towing equipment in the 22,500 to 35,000 lb. drawbar class to all these top airlines. In fact, "PAYMOVER" tractors are not only the choice of the leading national and international airlines for handling their largest jet aircraft, but of manufacturers and ground-handling contractors too.

We accept this overwhelming preference for "PAYMOVER" tractors as a challenge to continually improve and keep "PAYMOVER" design abreast of the future needs of the aircraft industry.

The complete line of "PAYMOVER" towing tractors also includes smaller units (as low as 2,500 lb. drawbar) for towing, pushing and other prime mover work at truck and railroad terminals, piers and industrial plants. Complete details and specifications will be supplied at your request.

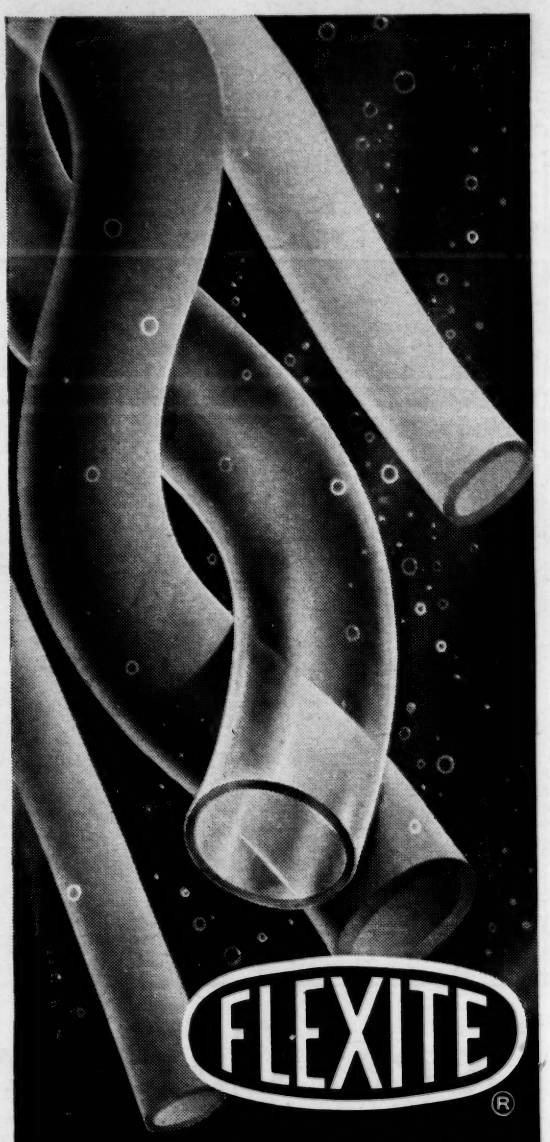
National Airlines
Northeast Airlines
Northwest-Orient Airlines
Pan American-Grace Airways
Pan American World Airways
Belgian World Airlines
Trans-Canada Air Lines
Trans World Airlines
United Air Lines
British West Indian Airways

HOUGH®

THE FRANK G. HOUGH CO. 3-E-2
LIBERTYVILLE, ILLINOIS
SUBSIDIARY — INTERNATIONAL HARVESTER COMPANY

THE FRANK G. HOUGH CO.,
976 Sunnyside Ave., Libertyville, Ill.
Send data on "PAYMOVER" tractor of .....lbs. drawbar effort
Name
Title
Company
Street
City State

Circle Number 156 on Reader-Service Card



FLEXITE®
TECHNICAL TUBINGS

Markel, leader for 38 years in tubing and sleeving, offers the FLEXITE line of technical tubings to meet mechanical, chemical, aeronautical, and electrical requirements.

Included under the FLEXITE trademark are precision-extruded tubings from a variety of materials—Teflon, silicone rubber, vinyl, polyethylene, and rigid vinyl—in a complete range of sizes and wall thicknesses.

What is your application? Call, write, or wire; we shall gladly furnish samples, data, and prices.

L. FRANK MARKEL & SONS
SINCE 1922
1 SOURCE for EXCELLENCE in
Insulating Tubings, Sleevings, and Lead Wire
NORRISTOWN, PENNSYLVANIA

Circle Number 157 on Reader-Service Card

sidy cost while increasing the airlines' profit levels. The reports were prepared by Planning Research Corp. and United Research, Inc.

Subsidies can be materially reduced, the Planning Research report found, by permitting the carriers to earn sufficient profits to purchase more modern aircraft, and by lifting of several restrictions on the airlines' route systems.

Key Problem

Key to reducing the subsidy bill, the report said, is the problem of increasing the industry's average load factor to a breakeven load factor of 69.2%. Each percentage point increase in load factor would produce an additional 2.2 cents of revenue per plane mile, adding an estimated $1.4 million to local service gross revenues for the year, the report pointed out.

Best method of lowering this breakeven need would be CAB authorization for local service schedules into more high density traffic areas combined with greater freedom of operation for the airlines, such as skip-stop and nonstop authority between major traffic points, the report stated.

Use of more modern aircraft also would aid in reducing the industry's operational costs on the basis of studies which indicate that DC-3 direct operation costs per seat mile are 2.3 cents over an 82-mi. stage length. Average costs of higher-seating-capacity Convair and Martin equipment are less than 2 cents per mile over a 102-mi. stage length.

Supporting the continued subsidization of the local service industry, the report emphasized that while subsidy has grown in the 10-year period since 1950, from $15 million to $37 million, the ratio of subsidy to revenues has declined. Ten years ago subsidy accounted for 53.9% of local service revenues, whereas the 1959 ratio amounted to only 33.6%.

Removal of trunk line competition at an estimated 100 cities on the present local service system was the predominant theme of the United Research subsidy reduction plan.

Trunk Competition

Contending that these low traffic potential points are a type of natural monopoly capable of supporting only one airline, the report estimated that elimination of this trunk competition would reduce annual local service subsidy needs by about $10 million. Additional savings could be realized by removing present CAB restrictions which require the airlines to make intermediate stops between these points as a means of protecting a competing trunk carrier, the report said.

Subsidized operations into 280 small

Local Service Airlines

Revenues and Expenses Year Ending Sept. 30, 1960

	OPERATING REVENUES				Total Operating Expense	Operating Profit (or Loss)
	Passenger	Total Non-mail	Mail and Subsidy	Total		
Allegheny	8,798,287	9,405,583	4,229,006	13,634,589	14,240,414	(605,825)
Bonanza	4,440,455	4,752,307	3,672,293	8,424,600	7,477,446	947,154
Central	2,337,775	2,553,155	3,271,063	5,824,218	5,678,410	145,808
Frontier	6,187,102	6,927,450	7,441,558	14,369,008	13,445,749	923,259
Lake Central	2,863,884	3,028,446	1,816,814	4,845,260	4,788,872	56,388
Mohawk	8,820,405	9,480,575	2,235,233	11,715,808	12,362,412	(646,604)
North Central	12,450,189	13,298,579	7,800,205	21,098,784	20,889,908	208,876
Ozark	7,308,374	7,882,518	4,077,042	11,959,560	12,129,498	(169,938)
Pacific	6,416,337	7,247,178	3,243,035	10,490,213	11,199,641	(709,428)
Piedmont	7,079,691	7,783,657	4,259,359	12,043,016	11,799,386	243,630
Southern	3,255,301	3,493,786	2,993,590	6,487,376	6,937,319	(449,943)
Trans-Texas	4,938,091	5,436,591	3,079,655	8,516,246	8,444,403	71,843
West Coast	6,101,435	6,353,629	6,080,986	12,434,615	11,538,202	896,413
Totals	80,997,326	87,643,454	54,199,839	141,843,293	140,931,660	911,633

Source: Ray and Ray

Local Service Aircraft

(4th Quarter, 1960)

Carrier	DC-3s	Convairs	Martins	F-27s	Total
Allegheny	9	13[1]	12	....	34
Bonanza	2	....	....	8	10
Central	15	....	....	....	15
Frontier	25	5	....	....	30
Lake Central	12	....	....	....	12
Mohawk	7	14	....	....	21
North Central	32	7	....	....	39
Ozark	24	....	....	3	27
Pacific	7	....	12	6	25
Piedmont	17	....	....	8	25
Southern	26	....	....	....	26
Trans-Texas	25	....	....	....	25
West Coast	14	....	....	6	20
Totals	215	39	24	31	309

[1] Includes Four Eland Powered 540's

Source: Ray and Ray

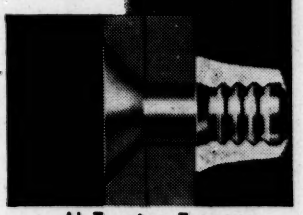
Local Service Airlines

Preliminary or Estimated Financial 1960 Results

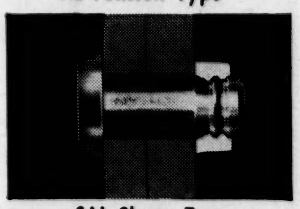
	OPERATING REVENUES				Total Operating Expense	Operating Profit (or Loss)
	Passenger	Total Non-mail	Mail and Subsidy	Total		
Allegheny	9,716,655	10,404,208	3,505,969	13,910,177	15,746,894	(1,836,717)
Bonanza	4,524,861	4,831,434	3,374,627	8,206,061	7,542,023	664,038
Central	2,406,260	2,631,667	3,352,913	5,984,580	5,676,164	308,416
Frontier	6,392,651	7,111,824	6,670,078	13,781,902	13,325,215	456,687
Lake Central	2,843,217	2,993,738	1,802,876	4,796,614	4,742,145	54,469
Mohawk	9,231,511	9,956,735	2,335,389	12,292,124	13,191,656	(899,532)
North Central	12,527,942	13,511,146	7,062,147	20,573,293	21,699,009	(1,125,716)
Ozark	7,609,285	8,234,621	4,070,518	12,305,139	12,319,626	(14,487)
Pacific	6,241,277	7,081,104	3,478,762	10,559,866	11,316,118	(756,252)
Piedmont	7,095,426	7,802,816	4,576,014	12,378,830	11,781,907	596,923
Southern	3,590,929	3,832,900	3,153,015	6,985,915	7,614,530	(628,615)
Trans-Texas	5,038,907	5,540,249	3,600,337	9,140,586	8,613,740	526,846
West Coast	6,209,020	6,480,415	5,533,820	12,014,235	11,308,799	705,436
Totals	83,427,941	90,412,857	52,516,465	142,929,322	144,877,826	(1,948,504)

Source: Ray and Ray

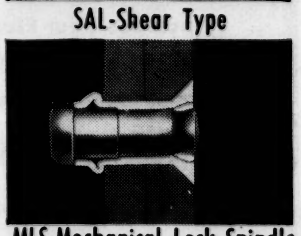
are the answer



AL-Tension Type



SAL-Shear Type



MLS-Mechanical Lock Spindle

MS-Blind Rivet

BL-Blind Huckbolt

Whether you want dependable strength under intense heat or speed of application for a "hot" production schedule, you can get either or both with Huck aircraft fasteners.

Huck standard or specially engineered fasteners are a dependable part of practically every craft plying the airways of the world or orbiting the globe.

These fasteners, specially engineered for aircraft use, are available in sizes, grips, headstyles and metals to meet your needs.

Huck fasteners are easily installed up to thirty per minute with complete uniformity of tensile preload. Installed savings up to seventy per cent of former fastening methods have been accomplished.

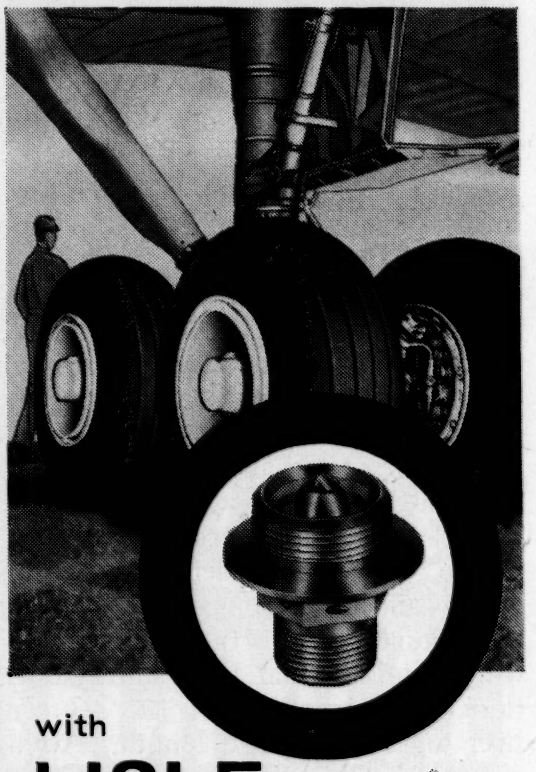
We invite your inquiries.

HUCK *MANUFACTURING COMPANY*

2480 Bellevue Avenue • Detroit 7, Michigan • Phone WA 3-4500

Circle Number 158 on Reader-Service Card

ENGINE FAILURE DETECTION BEFORE TAKEOFF!



with

LISLE *Magnetic* **CHIP DETECTORS**

Detection of impending in-flight failure of engines, hydraulic systems, constant speed drives and other critical installations can be accomplished **before** take-off, when it really counts!

Metal particles in an engine or accessory lubricant are a proven indicator of impending internal breakdown. The Magnetic Chip Detector attracts these particles which bridge an electrically insulated gap and complete a circuit which activates a warning light on the instrument panel.

Early detection means constant protection against in-flight failure.

Write for Catalog and Samples for Testing

LISLE CORPORATION
Clarinda, Iowa

Circle Number 159 on Reader-Service Card

communities, which have only local service flights, should be continued as a reasonable investment of public funds, the United study said.

Local service operations into these smaller airports have required heavy subsidy support, the study said, since the average cost of providing this service for each airport is estimated at $40,000 annually per airline.

On the basis of 1959 figures these points produced about $5 million in revenues and required $12.5 million in subsidy payments, United researchers found.

Supports CAB Plan

The report also gave strong support to CAB's class mail rate plan as a practical means of controlling and predicting the airlines' subsidy needs, while affording their managements with incentives to lower operational costs.

Designed to replace the present subsidy formula, based on paying the carrier the difference between its revenues and expenses plus a return on investment, CAB's class mail rate includes a new rate of return ranging from 9 to 12.75% applied to a sliding scale of rates based upon volume of operations per station. A subsidy rate of 3.11 cents per available seat mile would be paid a carrier operating 300 revenue plane miles per station per day. The rate would decline to only 1.90 cents on the basis of 600 mi. per station and flight frequencies beyond this amount would not receive subsidy.

The plan also includes a profit sharing provision under which the airlines would rebate to CAB 50% of any profits earned between their established rate of return and a return of 15% on investment, and 75% of the profits in excess of the 15% return.

Subsidy Changes

Problems which it experienced in the past handling of complex subsidy formulas, permitting carriers to switch back and forth from open to final mail rates, have served to highlight a need for the new subsidy formula, CAB said. During the last two years, the Board said, the local service carriers were on open rates 80% of the time as a result of adding new routes or transition to new flight equipment. Problem of this system was that there was never any accurate knowledge of what the airline's year-end subsidy bill might be. Tabulation of a carrier's subsidy bill at the end of the period created a heavy and continuous workload for the Board and often resulted in large retroactive payments to the airline or disagreements as to what expenses would be allowed for subsidy coverage.

In general, the Board found that the local service operators too often failed to schedule their operations with maximum efficiency while on the open rate basis because of the knowledge that any schedules added would be covered by subsidy.

Since the new formula applies only to final mail rates, CAB concentrated last year on getting all local service airlines on final rates. At the end of the year, the Board had settled seven of the eleven rates which had been open, but four final rates were reopened at the request of the carriers during 1960 and January, 1961. Currently eight of the thirteen local service carriers are now on open rates, and cannot be placed under the class mail rate plan.

Local Service Airlines

Comparison of operating statistics years 1959 and 1960

	1959	1960	INCREASE 60/59 Amount	INCREASE 60/59 Per cent
Revenue Plane Miles (000)	87,145	94,792	7,647	8.8
Revenue Passenger Miles (000)	1,057,134	1,170,779	113,645	10.8
Originating Passengers	5,328,706	5,695,958	367,252	6.9
Enplaned Passengers	5,649,324	6,056,057	406,733	7.2
U. S. Mail Ton Miles	2,199,332	2,714,125	514,793	23.4
Express and Freight Ton Miles	5,335,125	6,272,201	937,076	17.6
Average Passenger Load (Persons)	12.1	12.4	0.3	2.5
Passenger Load Factor %	44.9	42.3	(2.6)	——
Total Revenue Ton Miles (000)	108,911	121,174	12,263	11.3
Ton Mile Utilization (%)	45.7	42.9	(2.8)	——
Average Revenue Load (Tons)	1.25	1.28	0.03	2.4
Performance Factor (%)	97.2	97.0	(0.2)	——
Revenue Hours	572,063	606,111	34,048	6.0
Off-on Speed (m.p.h.)	152.3	156.4	4.1	2.7
Number of Departures	985,986	1,028,819	42,833	4.3
Average Length of Hop (Miles)	88.4	92.1	3.7	4.2
Daily Aircraft Utilization	5:39	5:33	(0:06)	(1.8)
Average Length of Journey:				
Originating Psgr	198	206	8	4.0
Enplaned Psgr	187	193	6	3.2
As of Fourth Quarter:				
Number of Aircraft	294	309	15	5.1
Number of Employees	11,440	12,413	973	8.5
Number of Stations	488	512	24	4.9
Route Miles Operated	46,468	47,473	1,005	2.2

Source: Ray and Ray

LOCAL SERVICE AIRLINES

Earnings History (Thousands of Dollars)

	Total Operating Revenues (includes mail pay)	Total Operating Expenses	Net Operating Income	Net Profit (or loss) After Taxes and Interest
1949	21,418	21,871	(453)	(1,451)
1950	27,870	27,206	664	(566)
1951	36,741	35,993	802	202
1952	42,379	43,497	(1,118)	(486)
1953	49,358	50,903	(1,545)	(2,033)
1954	54,715	53,105	1,610	958
1955	57,450	56,764	686	352
1956	67,712	68,293	(581)	(801)
1957	82,139	82,900	(760)	(1,153)
1958	94,934	93,277	1,657	1,109
1959	122,822	122,078	744	232

Source: Ray and Ray

U.S. Aircraft Engaged in Air Transportation

SCHEDULED AIR CARRIERS, DOMESTIC & INTERNATIONAL AS OF DEC. 31, 1960

	Boeing			Convair			Curtiss	Douglas					Fairchild	Lockheed				Martin		Vickers		Grumman	Totals
OPERATOR	707	720	377	880	540 440	340 240	C46s	DC8	DC-7*	DC-6†	DC-4	DC-3	F-27	188	1649	1049‡	749z	404	202	V810	V745	G21-A	
Allegheny					12							9							12				33
American	24	9				46			33	62				33									207
Bonanza												1	8										9
Braniff	4					31	2		5	11		1		8									62
Capital										11	10	10									51		82
Caribbean Atlantic												7											7
Central												15											15
Continental	5								5			8								13			31
Delta				9		26	5	6	20	11		10											87
Eastern					20			11	48	7				39		38	1	52					216
Frontier						5						25											30
Lake Central												12											12
Mackey B											3	2											5
Mohawk					5	10						4											22
National					6			3	8	12				12		4							45
North Central						7						32	3										42
Northeast				4						10		6									10		30
Northwest								4	15	22	8			9									58
Ozark												24	3										27
Pacific												7	6					8	3				24
Panagra								3	6	2													11
Pan American	29		3					16	32	29	18												127
Piedmont												17	8										25
Resort A											9												9
Southern												26											26
Trans-Texas												25											25
Trans World	27			1											25	40	68	20					181
United		11				32		32	45	72													192
West Coast												14	6										20
Western	2					4				27				6									39
CARGO LINES																							
AAXICO A							33																33
Aerovias Sud Americana							2			3	2												7
Flying Tiger							2									12							14
Riddle							2		1		3												6
Seaboard & Western							1				3	1				9							14
Slick																5							5
HAWAIIAN AND ALASKA LINES																							
Alaska Airlines							2			3	2												7
Alaska Coastal																						7	7
Aloha												3	6										9
Cordova							1					2											3
Ellis																						8	8
Hawaiian						8				2		6											16
Northern Consolidated													3										3
Pacific Northern												3					6						9
Reeve Aleutian							1				2	2											5
Wien Alaska							4					1	2										7
Total: All Domestic and International Aircraft	91	20	3	14	43	169	55	75	218	284	60	276	45	107	25	108	75	80	15	13	61	15	1,852

*=DC-7, -7B, 7C. †=DC-6, -6A, -6B. ‡=1049, 1049C, 1049G, 1049H. z=749 & 049. s=C46 & CW20T. A=as of June, 1960. B=as of October, 1960.
Compiled by AVIATION WEEK from figures supplied by Federal Aviation Agency's Statistics Division, Office of Management Services.

RIDDLE AIRLINES' ARMSTRONG WHITWORTH AW 650 ARGOSY

Trunk, All-Cargo Line Showdown Looms

Washington—Cargo carrier competition with domestic trunklines for dominance of the future mass market in air cargo appears headed for a decisive test this year as the freight airlines pit newly acquired turboprop equipment against their competitors' older piston engine cargo liners.

The cargo carriers are betting that special aircraft designed for cargo can produce lower cargo rates through more economical operation.

Although the trunks registered a reasonable gain in revenue ton miles carried last year while the cargo carriers recorded a decrease, both have had to revise past estimates on a general cargo breakthrough and agree that the long sought mass market will not be attained until the industry finds the ideal aircraft for this purpose.

Flying Tiger, Seaboard & Western and Slick, all of which have placed orders for the Canadair CL-44D turboprop swingtail aircraft for long-range cargo hauling, and Riddle Airlines which has ordered a fleet of seven Armstrong Whitworth AW 650 turboprop freighters for short-haul use, are convinced these aircraft will operate at a low enough cost to justify a lowering of the cargo rate floor by the Civil Aeronautics Board.

Trunk carriers continue to rely upon conversions of their surplus Lockheed L-1049 and Douglas DC-7 equipment for cargo pending development of turbofan freighters with a higher load capacity and speed than turboprops. While several of the airlines have shown interest in proposals made by the Boeing Airplane Co. for a swingtail cargo turbofan, the Boeing 735, and the Douglas Aircraft Co. for a cargo version of the DC-8, industry selection of a cargo aircraft is considered unlikely until the Department of Defense concludes its studies on a new cargo aircraft to modernize the Military Air Transport Service.

Revenue Figures

Combined industry revenue ton miles for mail increased to 143,600,000 last year for a 15% gain over 1959. Express revenue ton miles—59,000,000—were up 3.5% over the previous year and freight increased about 3% to reach 590,900,000 revenue ton miles last year.

The industry's growth rate in revenue ton miles of cargo, which increased nearly 16% in 1959 over 1958, registered a gain of only 5% last year with a revenue ton mileage of 793,500,000. This reflected a cutback in available freight ton miles by AAXICO, Aerovias Sud Americana, Flying Tiger and Riddle.

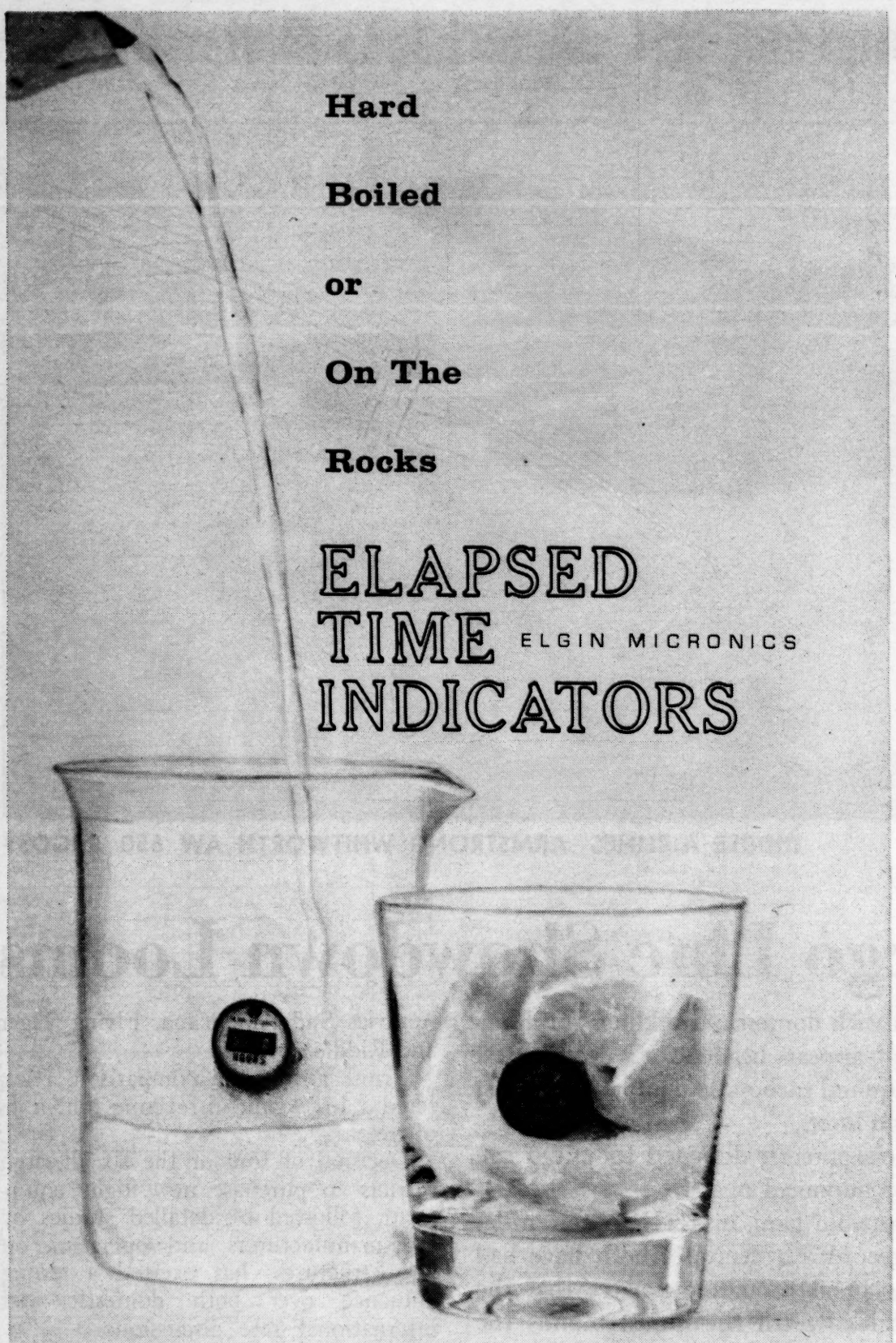
Trunk airlines, in comparison, registered a 14% gain in revenue ton miles of freight.

Decision of four of the six all-cargo carriers to purchase new flight equipment, followed by detailed studies by the manufacturers and operators on rate structures, has exerted a strong influence over both domestic and international rate discussions.

Seaboard Proposal

Seaboard & Western proposed a new table of reduced transatlantic cargo rates, tailored to its fleet of five CL-44s expected to go into service July 1, at a conference last month of the International Air Transport Assn. Designed to encourage volume cargo shipments, Seaboard's tariffs offer lower rates as the volume is increased. The cost of shipping 2,200-5,000 lb. of cargo from New York to London would be only 78 cents per pound under the Seaboard tariff structure compared with 83 cents charged under the present system.

Illustrating the incentive features provided by this volume discount tariff, the airline pointed out that whole shipments totaling 65,000 lb., the maximum payload capacity of the turboprop aircraft on the transatlantic route, would be only 28 cents per



Hard

Boiled

or

On The

Rocks

ELAPSED TIME INDICATORS

ELGIN MICRONICS

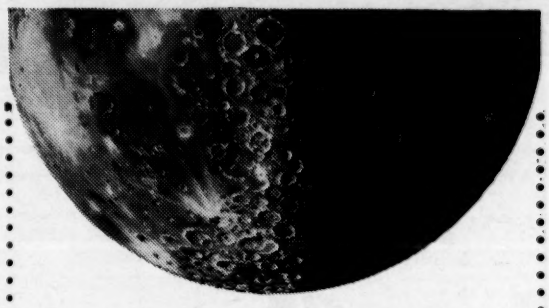
Hot or cold, anything between –65°F (cold enough to freeze even the driest martini) and 185°F is just comfortable for an Elgin Micronics ETI. If the heat is really on, they can be made to take 250° F, and they're hermetically sealed to operate in any atmosphere—or in no atmosphere at all! No wonder they're preferred by the men who design high-performance, high-flying equipment when they want true reliability data. Elgin Micronics Elapsed Time Indicators are small enough (only .680″ in diameter) to fit anywhere and surpass MIL-M-26550A with ease. Write for bulletin ETI-1 today and check the detailed specs against your requirements.

ELGIN MICRONICS

DIVISION OF ELGIN NATIONAL WATCH COMPANY 366 Bluff City Blvd., Elgin, Illinois

Plants in Elgin and Rolling Meadows, Illinois and Chatsworth, California

Represented nationally by Airsupply-Aero Engineering Company, a division of The Garrett Corporation



MATHEMATICIANS and STATISTICIANS

CAREER POSITIONS IN SOUTHERN CALIFORNIA

Mathematicians to develop programs that transform design intent into the definitions required for numerically controlled tools. Will mathematically define rocket engine components. A degree in Mathematics is required.

Research Statisticians to participate in planning long range rocket research and development programs, with the majority of time spent in statistics research. Will take part in the development of statistical and mathematical methods for optimizing a set of experimental designs for large, complex programs. An advanced degree in Statistics is preferred.

Reliability Statisticians to perform analytical investigations requiring the use of reliability techniques of measurement, synthesis, and prediction. Will conduct studies to determine relationships between reliability and other parameters. A degree in Statistics or Engineering with statistical training is required.

Send inquiries to:

Mr. A. C. Stoetzel
Professional
Employment Office
6633 Canoga Avenue
Canoga Park, California

ROCKETDYNE

DIVISION OF NORTH AMERICAN AVIATION

Circle Number 166 on Reader-Service Card

pound as opposed to 88 cents per pound between New York and Paris.

IATA members failed to reach an agreement either on adopting this type of tariff or lowering the rates on specific commodities listed under the present system. Since the present rates will expire Apr. 10, the airlines will be free to implement whatever tariff structure they favor. If this situation develops, Pan American World Airways and Trans World Airlines, both of which supported the volume discount formula, say they are prepared to introduce rates which will reduce shipping costs an average of 50%.

Under a current Civil Aeronautics Board study of domestic cargo rates, Flying Tiger has filed a series of new tariffs which it claims will reduce the airline's present cargo rates by at least one third for transcontinental flights. As an example, the carrier estimates that the speed, capacity and newly designed ground handling equipment for the CL-44 will drop the cost of shipping 100 lb. of office machinery from San Francisco to New York from the present rate of $14.05 to $10.05. Flying Tiger predicts that its new cargo handling facilities at O'Hare airport, Chicago, will eventually permit servicing turn-around schedules on the CL-44 in less than 45 min.

Recognition of Flying Tiger's purchase of the Canadair aircraft and Riddle's AW 650s also was cited by a CAB Examiner who last month recommended that Flying Tiger be granted permanent certification as the sole all-cargo line on a transcontinental route and Riddle as the only cargo carrier on a north-south route. Examiner Merritt Ruhlen, in his initial decision in the two-year-old Domestic Cargo-Mail Service Case, said he favored Flying Tiger over Slick for the east-west route because of Flying Tiger's better financial status, its steady rate of growth and more definitive plans for the introduction of CL-44 service. Slick, he noted, had suspended its scheduled service for more than two years and indicated that it would not resume the service until a final CAB decision in the cargo case.

AAXICO was similarly ruled out in favor of Riddle by the Examiner, who pointed out that AAXICO not only has no definite plans to re-equip with modern cargo aircraft but also dropped its regularly scheduled service 18 months ago.

Although optimistic over the untapped potential of the air cargo industry, Ruhlen cautioned that the promised volume does not appear sufficient to justify the certification of competing all-cargo carriers at this time. On this basis, the Examiner recommended that Riddle be eligible for subsidy for a five-year period on the north-south route and that Flying Tiger should be certificated on a non-subsidy basis in line with the airline's statement that subsidy would not be requested unless it is permitted for a competing all-cargo airline.

Riddle is going ahead with its own plans to tap a mass market and has talked with CAB about the possibility of merging with a supplemental airline to offer a low cost, scheduled airbus service. Approval of the plan would solve Riddle's problem of aircraft utilization, the airline said, since 90% of its service now moves only between midnight and dawn on a predominantly five-day-a-week basis.

A proposal for a similar type of service is now being considered by Hawaii, where a state-sponsored survey has recommended the establishment of a state-owned air ferry service. A fleet of three AW 650 aircraft would be used to connect the state's six main islands. The service would be operated under a state subsidy by either Aloha Airlines or Hawaiian Air Lines.

Riddle also purchased seven DC-7C freighters, which it contends can be operated at direct operating costs as low as the CL-44, in addition to its fleet of 26 C-46s and 2 DC-4s. Guaranteed loan legislation for the purchase of modern cargo aircraft and the early selection of an optimum cargo aircraft for MATS is favored by Riddle, which claims that competition from trunk airlines is one of the all-cargo operator's biggest problems. Passenger carriers get nearly 50% of their cargo revenues from high-yield mail and express, which can be carried in the cargo holds of passenger aircraft, Riddle said. The CAB should place restrictions on the amount of this type of cargo handled by the trunks to strengthen the all-cargo operators and aid in the expansion of all-cargo service to the top 100 cities, the airline says.

Legislation authorizing government guaranteed loans of up to $75 million per airline for the purchase of cargo aircraft will probably be reintroduced this year by Sen. A. S. Monroney (D.-Okla.). Supported by the Department of Defense, the Federal Aviation Agency and the Civil Aeronautics Board, the bill encountered strong opposition last year from major trunk airlines and Flying Tiger, which already had concluded a purchase agreement with Canadair under a Canadian government insured loan. Industry observers feel that the bill may have a better chance of acceptance this year because of the interest expressed by the new Administration in measures which might stimulate the economy.

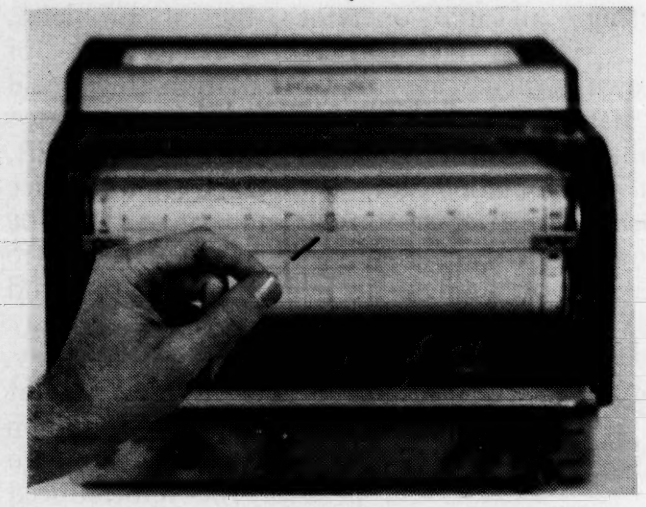
Air Cargo in Scheduled Service 1959-1960

	THOUSANDS OF REVENUE TON-MILES					
	Mail		Express		Freight	
	1960	1959	1960	1959	1960	1959
DOMESTIC TRUNK LINES						
American	23,454	22,549	12,059	10,531	112,325	100,571
United	36,545	31,281	11,416	11,978	77,143	74,103
Trans World	19,267	17,593	9,088	8,944	43,803	32,130
Eastern	14,794	12,490	6,419	6,183	21,622	17,026
Northwest	7,592	7,195	3,423	3,213	17,852	16,153
Delta	5,898	5,051	3,681	3,577	15,466	15,266
Braniff	5,136	4,171	1,978	2,184	7,476	7,803
National	3,949	3,822	794	880	8,023	7,055
Capital	6,512	5,927	3,474	3,225	5,621	4,689
Western	3,846	3,596	1,199	1,081	4,060	3,847
Continental	2,362	1,585	1,420	834	5,127	2,605
Northeast	1,552	1,257	490	471	2,658	1,352
Total Trunk	130,907	116,517	55,441	53,101	321,176	282,600
LOCAL SERVICE LINES	2,714	1,930	2,419	2,210	3,853	3,125
ALL CARGO LINES						
AAXICO	.....	41	.....	81	35,758	54,525
Aerovias Sud Americana	.....	.....	.....	.....	5,660	7,005
Flying Tiger	652	619	667	838	105,112	123,600
Riddle	243	106	382	331	24,074	38,322
Seaboard & Western	9,150	5,524	217	.....	40,836	34,795
Slick	.....	.....	.....	.....	54,595	30,111
Total Cargo	10,045	6,290	1,266	1,250	266,035	288,358

Source: Ray and Ray

New from TI

GERMANIUM CRYOMETER SYSTEM



- **Sustained Absolute Accuracy**
- **Complete Indicating and Recording System**

The TI Cryometer System combines a newly developed germanium probe and a special "servo/riter"* recorder to provide continuous indication and recording of temperatures in the cryogenic range. TI Germanium Cryometers offer fast response, unexcelled reproducibility and withstand continued cycling to room temperature without restandardization.

Two standard systems are offered. One specifically covers the liquid hydrogen range reading directly in degrees Kelvin. The second covers the 1°—40° Kelvin range in five steps.

Write for complete information

APPARATUS DIVISION

TEXAS INSTRUMENTS
INCORPORATED
3609 BUFFALO SPEEDWAY • HOUSTON 6, TEXAS

* A trademark of Texas Instruments Incorporated

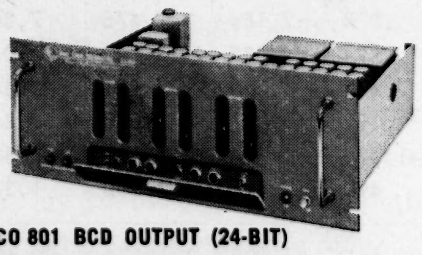
423

Circle Number 167 on Reader-Service Card

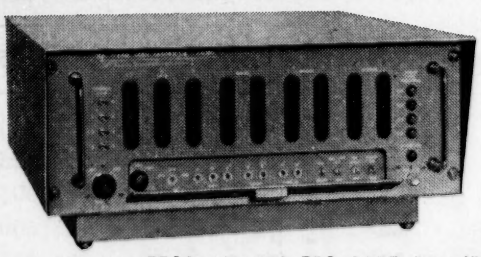
TIME TEAM

HOW EECO'S ALL-STAR LINEUP OF TIME CODE GENERATORS WINS ON EVERY POINT

Look at these unparalleled advantages offered by EECO Time Code Generators! Frequency stability, 3 parts in 10^8, based on extremely stable crystal oscillator. 100% plug-in circuits to keep generator working for you day in and day out. Emitter-follower low-impedance outputs for long-distance transmission. Wider operating-temperature stability. Operable from aircraft power. Provision for external frequency standard. Auxiliary pulse rates.



EECO 801 BCD OUTPUT (24-BIT)



EECO 810 100 PPS CODE (36-BIT)

Model Number	Serial Code Format	Time Indication	Code Frame Length (SEC)	Code Scan Rates (PPS)	Code Carrier Frequency (CPS)	Price (f.o.b. Santa Ana)
EECO 801	24-Bit, 24-hour, BCD	hr. min. sec.	1	25, 50, 100	1000	$7500
EECO 802	17-Bit, 24-hour, Binary (Eglin AFB)	hr. min. sec.	1	20, 100	1000	$7000
	13-Bit, 24-hour, Binary (Patrick AFB)	hr. min. ¼ min.	15	1	1000	
EECO 802M1	17-Bit, 24-hour, Binary (Atlantic Missile Range)	hr. min. sec.	1	100	1000	$7000
EECO 802M2	17-Bit, 24-hour, Binary (Atlantic Missile Range)	hr. min. sec.	1	20, 100	1000	$7000
			20	1		
EECO 803	20-Bit, 24-hour, BCD	hr. min. sec.	1	25	250	$7500
EECO 804	20-Bit, 24-hour, BCD	hr. min. sec.	1	25	100 W/1000	$7925
EECO 810	36-Bit, 365-day, BCD	day hr. min. sec.	1	100	1000	$10,100
EECO 810M1	23-Bit, 365-day, BCD (IRIG Member C Format Modified)		60	2	1000	$10,100

SEND FOR TIME CODE GENERATOR FILE 301

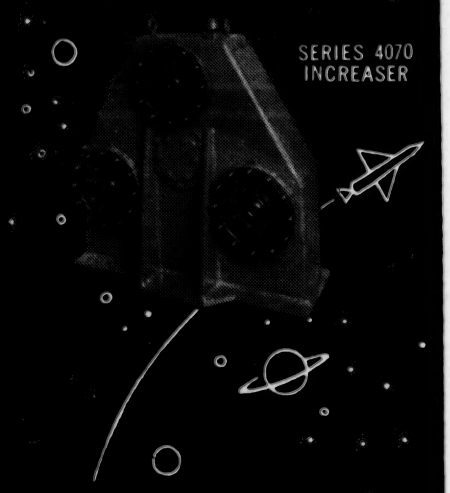
Electronic Engineering Company *of California*
1601 East Chestnut Avenue • Santa Ana, California • KImberly 7-5501 • TWX: S ANA 5263

EE 1-27

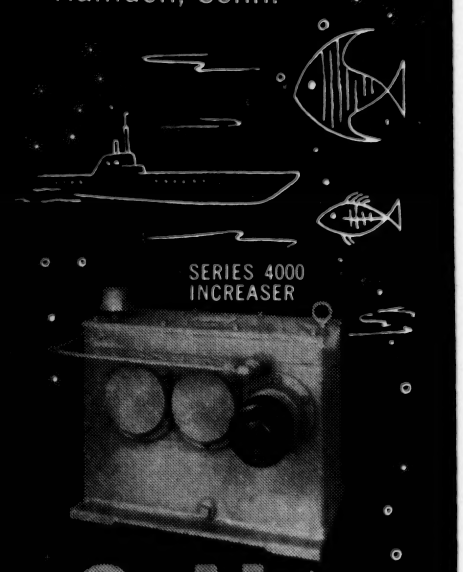
Circle Number 168 on Reader-Service Card

for way up here

S-N



S-N engineers want to recommend the best high speed gear increaser for your test applications.
S-N wants to tell you why S-N units have been chosen by engineers for aero-space systems as well as atomic submarines.
S-N wants to send you a bulletin about a specific application of interest to you.
S-N wants you to write Industrial Division The Snow-Nabstedt Gear Corporation, Hamden, Conn.



S-N

for way down here

Circle Number 169 on Reader-Service Card

Federal Airport Fund Outlook Improves

By Ford Eastman

Washington—Proposals to increase federal participation in airport modernization and expansion programs stand a better chance to receive Congressional approval this year than at any time since Congress passed a four-year airport aid act in 1955.

Although efforts were made in Congress in 1959 to boost the federal aid plan to a point more in line with industry and community requirements, the threat of a Presidential veto resulted in a two-year extension of the 1955 act at a $63 million annual level.

The extension, which authorizes the government to match, on a 50-50 basis, local and state funds for airport construction up to a total of $63 million a year, expires June 30 this year.

Sen. Norris Cotton (R.-N.H.), ranking minority member of the Senate interstate and Foreign Commerce Aviation Subcommittee, has already introduced a bill to extend the federal aid to airports program for another four years at $70 million annually. The bill was co-sponsored by Senators Andrew F. Schoeppel (R.-Kans.) and John Marshall Butler (R.-Md.).

This indicates a change in attitude on the part of the Republicans toward federal aid to airports since the Eisenhower Administration advocated a gradual phase out of federal participation in the program, forcing the state and local governments and industry to stand the cost of airport modernization and expansion on their own.

Sen. A. S. Mike Monroney (D.-Okla.) chairman of the Aviation Subcommittee, will also ask for a four-year extension of the act, but at $100 million a year instead of the $70 asked by Sen. Cotton. Sen. Monroney introduced a similar measure two years ago which passed the Senate, but came out of a Senate-House Conference Committee as a two-year extension at the $63 million a year figure.

President John F. Kennedy's new Democratic Administration is expected to go along with Senate Democratic leaders who have long supported measures to increase federal aid to modernize and expand the nation's airports for these reasons:

- **Party platforms** commits the Administration to continue and expand the airport aid program.
- **Continuing and expanding** airport

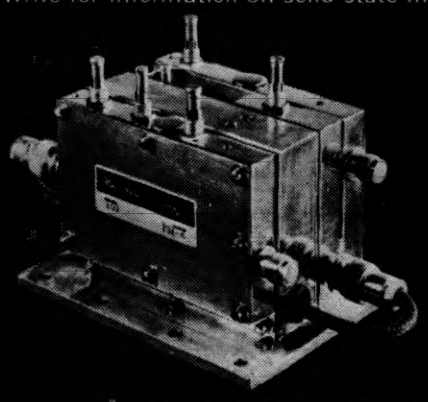
STATES	Publicly Owned Airports	Airports Reporting Projects Planned	Cost of Projects Planned	Funds Available and Anticipated from Local and State Sources	Additional Funds Needed
Alabama	53	4	$4,540,000	$2,105,150	$2,434,850
Alaska	256	117	27,594,500	11,174,750	16,419,750
Arizona	101	22	24,882,823	14,814,248	10,068,575
Arkansas	55	10	1,224,400	723,200	501,200
California	213	68	122,739,771	77,344,653	45,395,118
Colorado	58	11	18,959,723	11,821,307	7,138,416
Connecticut	7	13	18,345,400	9,791,750	8,553,650
Delaware	3	2	730,400	338,000	392,400
Florida	95	83	85,443,944	28,941,441	56,502,503
Georgia	52	15	59,150,600	29,754,600	29,396,000
Hawaii	13	8	25,197,200	12,598,600	12,598,600
Idaho	135	26	2,558,777	1,412,633	1,146,144
Illinois	56	58	47,363,600	20,371,300	26,992,300
Indiana	105	19	8,667,295	4,454,215	4,213,080
Iowa	83	22	10,547,677	6,009,177	4,538,500
Kansas	99	15	5,446,800	1,197,950	4,248,850
Kentucky	31	55	30,356,725	16,600,375	13,756,350
Louisiana	41	12	28,172,400	14,149,700	14,022,700
Maine	29	22	6,245,319	3,513,744	2,731,575
Maryland	11	8	19,360,100	10,425,121	8,934,979
Massachusetts	24	40	38,024,400	22,283,950	15,740,450
Michigan	125	92	84,629,646	53,835,848	30,793,798
Minnesota	103	52	14,472,510	9,134,391	5,338,119
Mississippi	44	64	13,843,600	7,151,000	6,692,600
Missouri	81	14	1,732,225	891,600	840,625
Montana	103	33	8,694,750	6,260,937	2,433,813
Nebraska	96	54	7,987,998	5,494,546	2,493,452
Nevada	15	5	8,049,080	6,197,290	1,851,790
New Hampshire	16	9	2,514,314	1,296,250	1,218,064
New Jersey	30	2	40,580,000	25,849,250	14,730,750
New Mexico	36	8	5,881,300	693,524	5,187,776
New York	46	17	88,432,550	42,904,695	45,527,855
North Carolina	59	3	5,280,700	2,669,000	2,611,700
North Dakota	112	27	4,853,400	2,745,600	2,107,800
Ohio	182	13	24,501,650	11,672,300	12,829,350
Oklahoma	74	23	13,967,000	7,744,186	6,222,814
Oregon	90	20	4,584,682	2,560,205	2,024,477
Pennsylvania	165	29	37,526,555	25,843,853	11,682,702
Rhode Island	5	5	5,813,470	3,257,720	2,555,750
South Carolina	55	24	17,982,420	7,716,000	10,266,420
South Dakota	57	47	4,244,995	2,173,295	2,071,700
Tennessee	63	63	37,577,673	21,454,500	16,123,173
Texas	227	58	49,722,784	12,379,061	37,343,723
Utah	46	20	4,352,522	900,450	3,452,072
Vermont	20	21	3,199,000	1,600,500	1,598,500
Virginia	31	12	5,153,607	2,626,000	2,527,607
Washington	13	14	13,852,400	7,312,818	6,539,582
West Virginia	42	9	6,403,300	3,545,066	2,858,234
Wisconsin	72	42	13,124,900	6,984,675	6,140,225
Wyoming	36	31	1,898,550	1,027,300	871,250
Total All States	3,564	1,441	$1,116,409,435	$583,747,724	$532,661,711
Ter. Puerto Rico	15	23	8,635,000	4,317,500	4,317,500
U. S. Total	3,579	1,464	$1,125,044,435	$588,065,224	$536,979,211

Unique Printed Stripline Circuitry

Micromega Varactor Multiplier

Micromega's Model FM-6 high-efficiency, high-power varactor multiplier is unique in its use of printed strip transmission line resonators at the low frequency of 150mc. FM-6 is to be used for tracking deep-space probes at the Goldstone Tracking Station of Jet Propulsion Laboratory.

Write for information on solid state microwave devices.



MICROMEGA FM-6 HIGH-POWER VARACTOR MULTIPLIER. Performance characteristics: Input Frequency, tunable from 145 to 165mc; Output Frequency, tunable from 870 to 990mc; Output Bandwidth, 30mc; Multiplication Factor, 3 × 2 = 6; Conversion Efficiency @ 2w input, −7db @ −20db spurious output and −8db @ −60db spurious output; Maximum Input Power, 2w; Operating Temperature Range, −50° C. to +75° C.

EMPLOYMENT. Opportunities for physicists and engineers.

Micromega Corporation

4134 Del Rey Ave., Venice, Calif. / EXmont 1-7137 An Affiliate of FXR, Inc.

Circle Number 165 on Reader-Service Card

BRIGGS OFFERS YOU, FREE, A 38 PAGE FIELD MANUAL . . . *covering aviation fueling, tank trucks, tank farms. Packed full with plans, specifications and actual photographs*

Get your copy of this practical and useful loose-leaf (constantly up-dated) field manual. It will indicate many ways to cut time and save on costs. If you are making plans for any size refueling operation, by all means write for your copy now.

Text covers ramp refueling, conversions, trucks, tanks, pumps and how to make some outstanding savings on piping . . . fully illustrated and written by engineers for operating personnel.

Briggs — PIONEERS IN MODERN OIL FILTRATION

FILTER/SEPARATORS

FOR REFUELING TRUCKS AND TANK FARMS

THE BRIGGS FILTRATION CO., Dept. 369, Washington 16, D. C.

YES! Send this manual at no cost or obligation to me.

Name .....

Company .....

Address .....

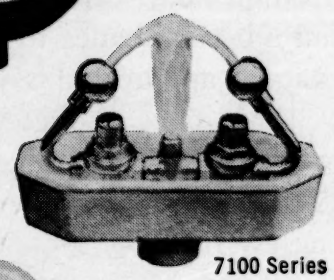
PRODUCT OF BOWSER RESEARCH

MAIL THE COUPON, NO OBLIGATION

Circle Number 170 on Reader-Service Card

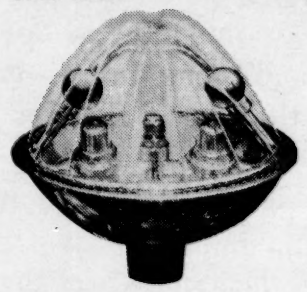
SAFETY by HAWS

7900 Series



7700 Series

7100 Series



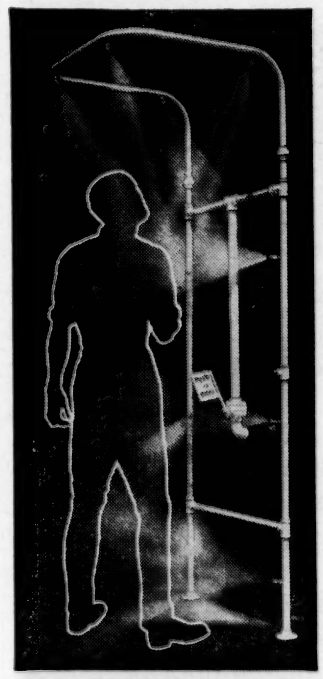
HAWS SAFETY FOUNTAINS

Wash harmful fuels and chemicals from eyes and facial areas, instantly! Prevent discomfort and serious injury. Units may be wall or pedestal mounted; with hand or foot operated quick-opening valves.

7900 Series—Maximum coverage eye/face-wash. 6 spray outlets in extra large stainless steel bowl set up soft, drenching mist for positive first aid. Large hand valve.

7100 Series—Eye-wash sends pressure-controlled streams from chrome plated brass heads. Acid-resisting enameled iron bowl.

7700 Series—Eye/face-wash simultaneously sprays water from perforated copper ring and fountain heads. Stainless steel bowl.



HAWS SAFETY SHOWERS

Instantly flood the body with torrents of rushing water to wash away injurious contaminants. Your choice of single head or multiple nozzle showers; available with hand or foot valves.

Model 8590— Multiple Nozzle Shower instantly drenches victim from all angles. Large hand valve.

WRITE FOR HAWS DETAILED SAFETY CATALOG TODAY!

HAWS SAFETY EQUIPMENT

a product of
HAWS DRINKING FAUCET COMPANY
1443 Fourth Street • Berkeley 10, California
Export Dept.: 19 Columbus Avenue
San Francisco 11, California, U.S.A

Circle Number 173 on Reader-Service Card

construction, especially in and around depressed areas, would provide more work for the unemployed and generally help stimulate the national economy.

• **Construction and expansion** of airport terminal facilities have not kept pace with the rapid growth and modernization of the air transportation industry and as a result the industry has moved into jet equipment without airports being fully prepared to meet them.

Defense Role

Another reason why the Administration may favor stepped-up airport construction is to improve national defense. If more airports which will accomodate heavy turbine powered aircraft are provided, the Strategic Air Command's heavy bombers can be harbored at these airports for brief periods as part of a dispersal program.

As of the end of 1960 there were 34 of the nation's major airports receiving commercial turbojet service. By 1964 another 45 major airports are expected to be ready to accommodate them.

Construction of new airports plus expansion and improvements required on existing airports to meet transportation needs and safety standards will cost an estimated $1.1 billion over the next four years, according to a joint survey completed by the Airport Operators Council, the American Association of Airport Executives and the National Association of State Aviation Officials.

The survey reflected the increasing demands of business aircraft and airline service at small and medium size communities as well as turbine powered aircraft at larger metropolitan areas. Out of the more than 3,500 publicly owned airports in the U.S. about one half are in need of immediate improvement, the survey showed.

Breakdown of the total estimated cost of planned airport development from July 1, 1961, to June 30, 1965:

• **Land acquisition**—13% of the $1.1 billion, or $146 million.

• **Landing area** development—55%, or $618 million.

• **Terminal building** construction—26% or $292 million.

• **Other terminal area development**—6%, or $67 million.

Local funds available for matching during the four-year period would amount to $527 million and state funds $61 million for a total of $588 million. This would require more than $536 million in federal matching funds, or an average of $134 million annually.

The Monroney bill that would provide $100 million a year would be $136 million short of meeting the matching needs over the four-year period and the Cotton bill would fall $256 million short. Since the survey contained projects considered desirable in addition to those termed essential, passage of the Monroney bill probably would fulfill the hard core requirements.

Sen. Monroney, in announcing his intention to introduce the legislation, said that under his plan matching funds would be available for runways and airport terminal facilities and other construction with the exception of bars and restaurants at the terminal.

Chances of the Monroney bill passing the Senate are good since similar proposals have had little difficulty in getting approval in the past.

The bill may have more difficulty in the House where Rep. John Bell Williams (D.-Miss.) chairman of the House Aviation Subcommittee, is far less enthusiastic over it than other Democratic leaders.

Rep. Williams has indicated that he is opposed to the spending of government funds in terminal areas unless it pertains to safety. In addition, he favors the appropriation of money on an annual basis.

Because of the long lead time required between planning of projects and the obligation of funds, appropriations on this basis could result in delays of the construction program several months each year. It was for this reason that the program was placed on a four-year basis in 1955.

DELIVERY: One Week Sooner

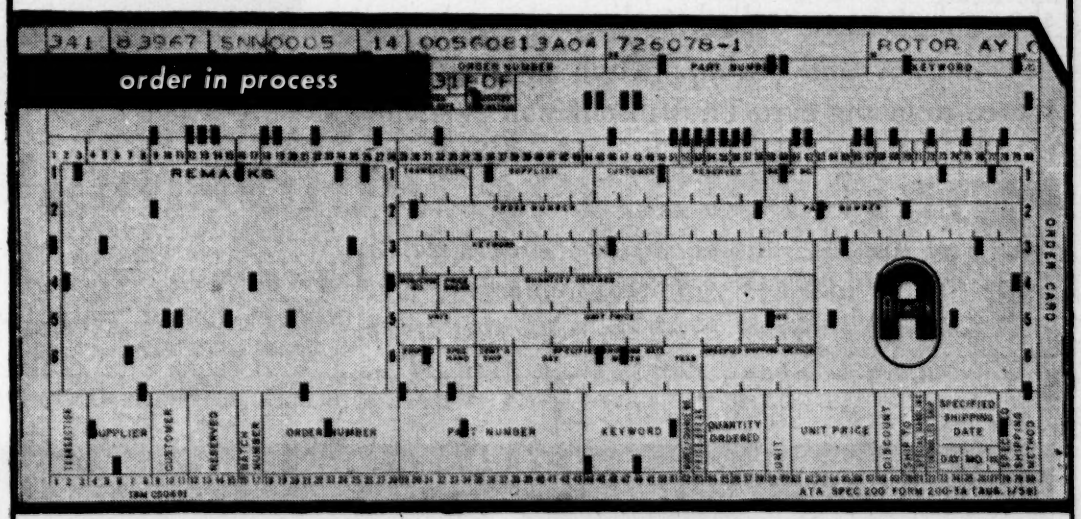
incoming order

Completely automated spare parts ordering conforming to ATA Spec 200, and covering the most important product lines in Aviation is now available from Airwork.

Three major airlines now use this time and money saving service.

For the past year and one-half, Airwork has been saving important lead time in airline provisioning and replenishment. This reduction in lead time has reduced customer capital requirements and inventory ... produced other important savings.

For full information, call your nearest Airwork branch office.



billing and order status information

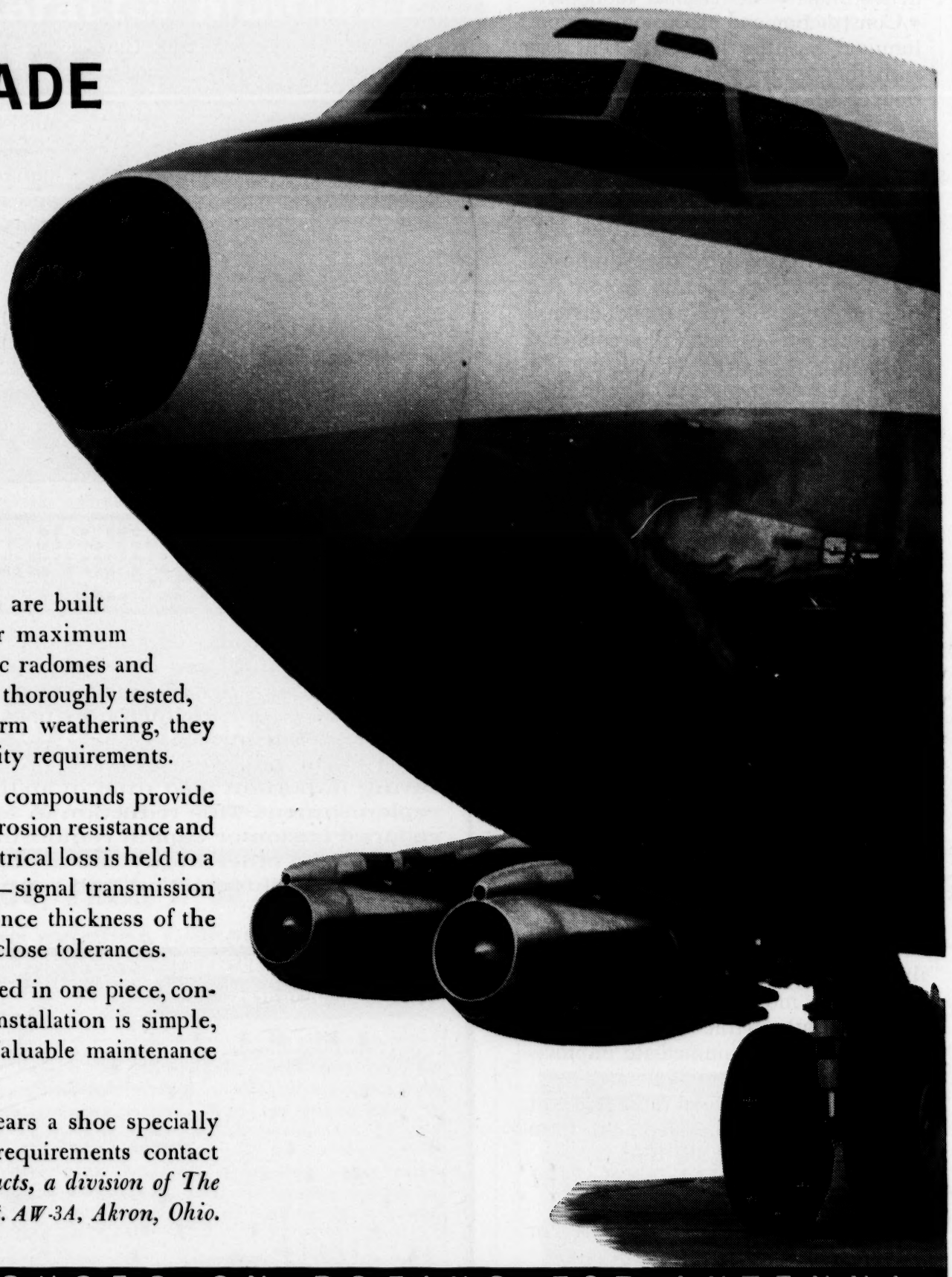
ESSENTIAL SERVICES TO AVIATION

Airwork CORPORATION
Millville, New Jersey

Circle Number 171 on Reader-Service Card

B.F.Goodrich

TAILOR-MADE RUBBER SHOES FOR WELL DRESSED RADOMES



B. F. Goodrich erosion shoes are built of special tough rubber for maximum protection of expensive plastic radomes and antenna covers. They've been thoroughly tested, they stand up under long-term weathering, they meet low temperature flexibility requirements.

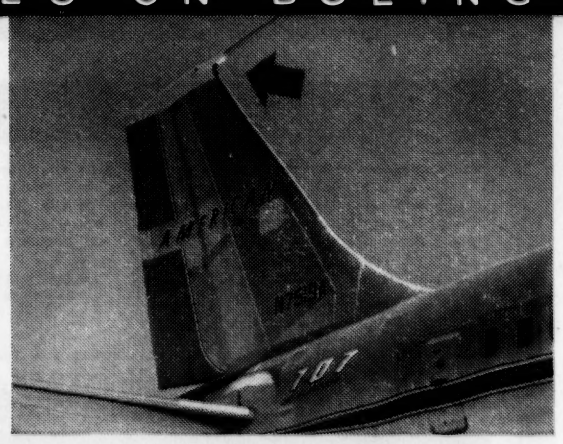
Special fabric-backed rubber compounds provide the best combination of high erosion resistance and low dielectric impedance. Electrical loss is held to a minimum. Equally important—signal transmission characteristics are uniform, since thickness of the shoe is factory controlled to close tolerances.

BFG erosion shoes are supplied in one piece, contoured to fit the part. Thus installation is simple, requires no special tools. Valuable maintenance man-hours are saved.

The well dressed radome wears a shoe specially made for the job. For your requirements contact *B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Dept. AW-3A, Akron, Ohio.*

EROSION SHOES ON BOEING 707 ANTENNA

UHF antenna

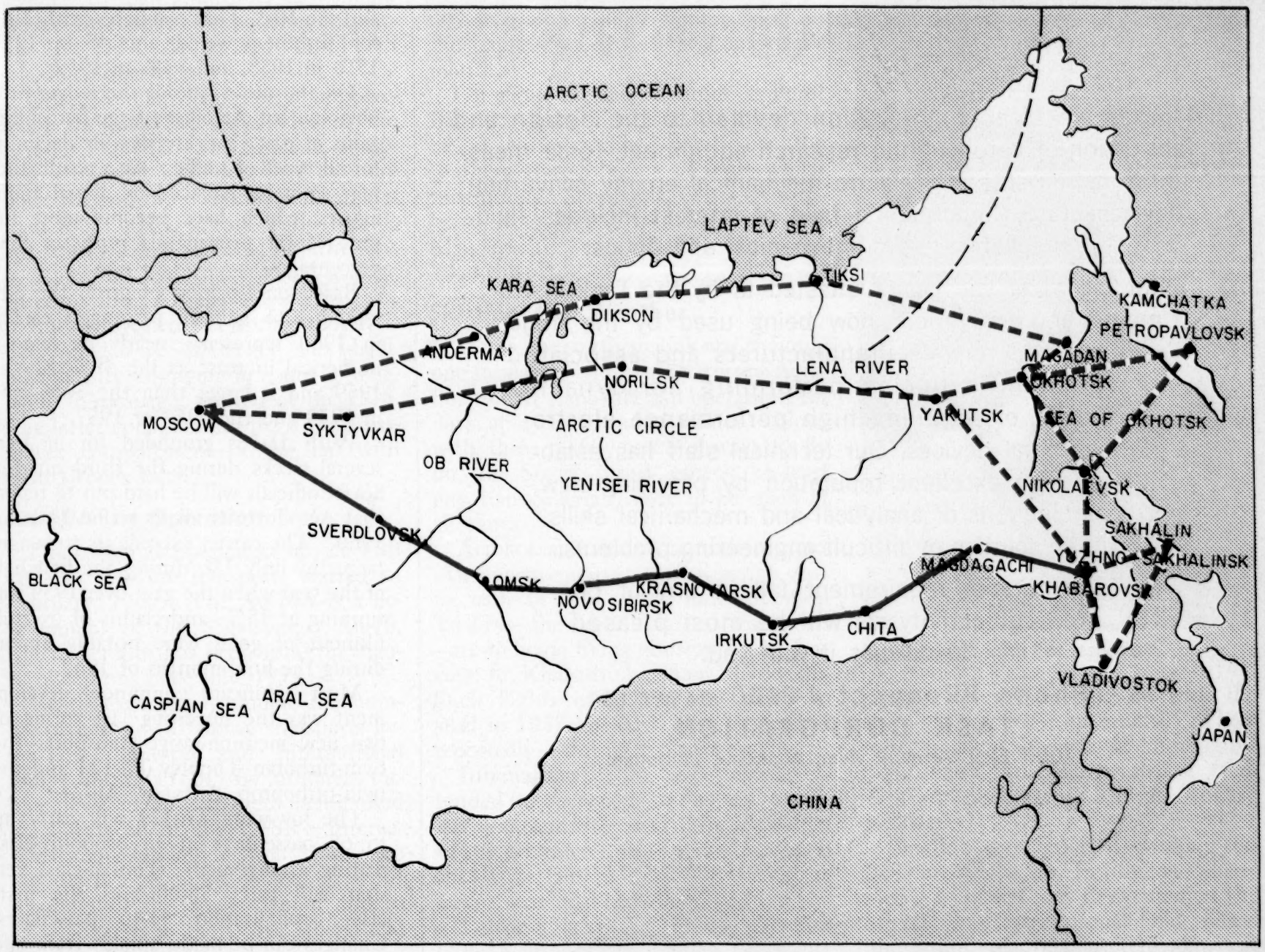


Fin probe antenna

Wing tip probe

B.F.Goodrich aviation products

Circle Number 172 on Reader-Service Card



DOUBLE TRACKING of Aeroflot's traditional trans-Siberian route to reduce or eliminate frequent weather delays began last year. The old route (bottom line on map) ran from Moscow to Vladivostock via Sverdlovsk, Omsk, Novosibirsk, Krasnoyarsk, Irkutsk, Chita and Magdagachi. An-10s and Il-18s began flying the alternate route via Norilsk, above the Arctic circle, last summer (center line on map). Proving flights by Il-18s have begun on a route even farther north—through Tiksi, which is 1,300 mi. north of a corresponding point on the old trans-Siberian route.

Equipment Problems Slow Aeroflot Gains

Russia's Aeroflot proved its worth as a highly-effective arm of Soviet foreign policy during 1960, while, at the same time, failing to achieve some of its goals as a commercial carrier.

Paradoxically, the four-turboprop Il-18, which demonstrated the USSR's ability to make its presence felt swiftly in such distant cold-war areas as the Congo and Cuba, was the same aircraft whose grounding denied Aeroflot its expected domestic traffic gains.

By year-end, with the Il-18 back in scheduled service but still the subject of disquieting rumors, Aeroflot could point to substantial progress during 1960 in most phases of its operations.

Percentage Obscurity

New records were set in passengers, mail and cargo carried. But the significance of these records in assessing the true volume of Aeroflot's traffic continued to be obscured by the Soviet statisticians' percentage game.

For the first nine months of 1960, Aeroflot carried about 34% more passengers than in the same 1959 period. Number of passengers on local routes doubled. Systemwide load factor for the first half of 1960 rose 6%.

Last spring, Aeroflot Chief E. F. Loginov claimed that the Soviet airline monopoly handled 20 million passengers in 1959. Thus, assuming a 30% gain for all of 1960, the total for last year would be approximately 26 million passengers against more than 58 million for all scheduled airlines in the United States.

Another set of statistics based on earlier data indicates that Aeroflot flew only about 16 million passengers last year, compared with 12.3 million in 1959 and 8.3 million in 1958. Both groups of figures show Aeroflot's passenger business virtually doubling in two years.

In either case, it appears that Aeroflot's net passenger gain for 1960 topped that of the U. S. airline industry and that the Soviet carrier is well along toward its goal of handling 50 million passengers in 1965, the last year of the USSR's current Seven-Year Plan.

Growing Air Share

Russia notes that Aeroflot's passenger business is increasing at a far faster rate than surface passenger transportation. In 1961, air passengers are expected to represent about 8% of the nation's total, compared with 3% in 1958.

Moreover, the quality of Aeroflot's equipment is improving. By late last summer, the Soviet airline was flying over half its total ton miles with twin-jet Tu-104s and four-turboprop Il-18s

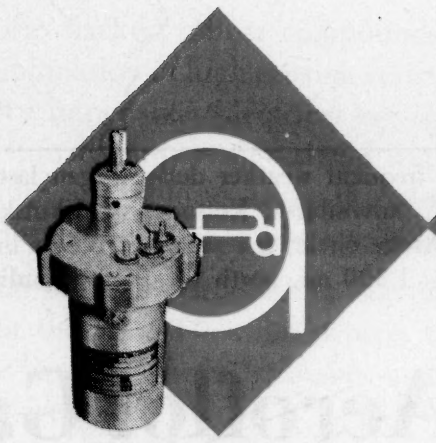
TASK'S FIELD OF INTEREST

A moderate sized organization devoted to the design and fabrication of aerodynamic research equipment, force measuring instruments and electro-mechanical energy converting devices; Task Corporation's field of interest includes fluid mechanics, solid mechanics, and optics.

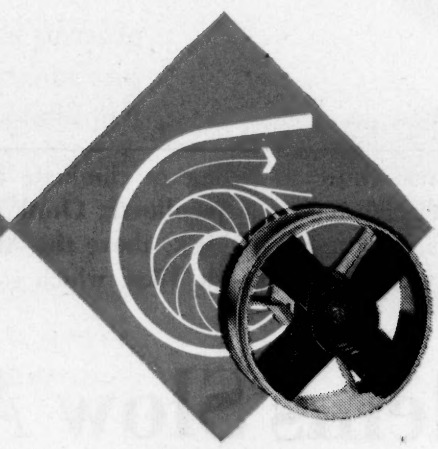
Our record of success is attested to by the Task instruments and equipment now being used by the major aircraft and missile manufacturers and associated government agencies performing aerodynamic research, or requiring high performance electro-mechanical devices. Our technical staff has established an excellent reputation by providing new combinations of analytical and mechanical skills in the solution of difficult engineering problems.

Should your requirement fall in any of our areas of activity we will be most pleased to discuss it with you.

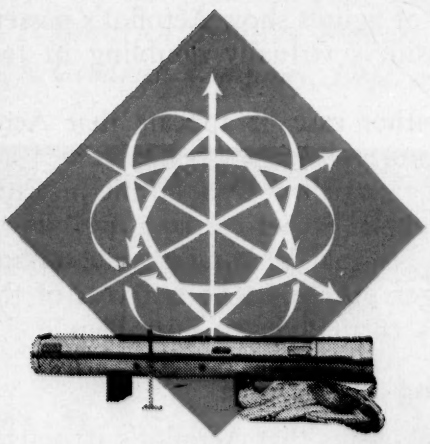
Phone PRospect 4-3100 or write:
TASK CORPORATION,
1009 East Vermont Ave., Anaheim, California.



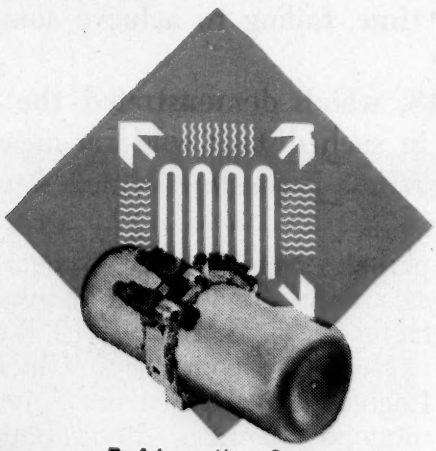
High Power Density, AC-DC Electric Motors



Pumps, Fans and Blowers



Aerodynamic Test Instrumentation



Refrigeration Systems and Equipment

TASK CORPORATION

Circle Number 174 on Reader-Service Card

and An-10s. This compares with 10% for turbine-powered aircraft in 1957, 17% in 1958, and 33% in 1959.

On the other side of the ledger, it is obvious that Aeroflot's huge percentage gains of past years are steadily declining for all types of traffic. As a result, they may soon be replaced by actual traffic figures, which have become more impressive for propaganda purposes than percentages.

Based on Loginov's figures, the estimated 30% gain in passengers carried in 1960 represents nearly as large a numerical increase as the 48% gain in 1959 and is larger than the 56% gain in 1958 and the 69% of 1957.

With Il-18s grounded for at least several weeks during the third quarter, Soviet officials will be hard put to report that Aeroflot met all its traffic goals for 1960. The carrier exceeds its passenger target by only 1% during the first half of the year when the gain over 1959 was running at 38%, and claims of overfulfillment of goals were notably absent during the final months of 1960.

Most significant equipment development was the unveiling last spring of two new medium-range transports—the twin-turbofan Tupolev Tu-124 and the twin-turboprop Antonov An-24.

The low-wing Tu-124 will carry up to 68 passengers in an economy-class seating arrangement. Tourist-class version will carry 55-60 and the first-class configuration 44-46 passengers. Changes can be made quickly from one to another without taking the airplane out of service.

Using Soloviev turbofan engines, the Tu-124 reportedly cruises faster than the Tu-104, which it resembles, and has a maximum speed of about 620 mph. Ceiling is around 39,370 ft.

Tu-124 Service

First scheduled service with the Tu-124 is planned for the Moscow-Perm and Moscow-Chelyabinsk routes. These links are about 725- and 925-mi. long.

The high-wing An-24 will carry 32 passengers in its basic version and 40 in its tourist configuration. Powered by two Ivchenko turboprop engines rated at 2,000 eshp., the airplane has a cruising speed of 325 mph. at 20,000 ft. Maximum range is about 1,250 mi. and ceiling is 26,250 ft.

Ton-mile operating cost for the An-24 is expected to be 25-30% less than for Soviet twin-engine, piston-powered aircraft as the Il-14. Both the An-24 and Tu-124 are designed for use on dirt runways unsuitable for the Tu-104 or Il-18.

Last May Aeroflot said that the An-24 and Tu-124 would be put into service "soon" and would "completely replace old, slow, piston-powered aircraft." Soviet definition of the word

"soon" is highly flexible, as demonstrated by Aeroflot's experience in placing the Il-18, An-10 and Tu-114 in scheduled operation.

Other Aeroflot equipment improvement included the appearance of the twin-jet Tu-104E. This airplane, equipped with what were described as more powerful and more economical engines than the Tu-104, set six world records last April when it carried 15 metric tons over a 2,000 km. course at an average speed of 596.12 mph.

Russia revealed last spring that it is developing a 125-passenger, short-haul, high-density configuration and a long-haul, 78-passenger version of the Il-18. The latter configuration has a third passenger compartment in the tail with eight sleeper seats.

An-10A In Operation

First scheduled passenger service with 100-seat An-10A transports started in February, 1960. The An-10A is a development of the 85-passenger An-10, which Aeroflot has been using in regular operations since July, 1959.

Russia expected to double the number of jet and turboprop transports flying on domestic and international routes during 1960. By summer, turbine-powered aircraft were being used on almost all of the USSR's international routes as well as from Moscow to the capitals of most of the other 14 republics in the Soviet Union and to all large cities in the Urals, Siberia and the Soviet Far East.

Aeroflot's timetable last summer announced 24 new Tu-104 and Il-18 routes. The absence of more An-10 operations revived speculation that the Ukraina is not performing as well as expected.

During its peak traffic period last summer, Aeroflot was scheduling over 800 flights daily on its domestic route system. Biggest passenger volume was over the short-haul Moscow-Leningrad route, where a dozen or more 100-passenger Tu-104B roundtrips were made daily. New Tu-104B service in 1960 included Khabarovsk-Petropavlovsk, Kamchatka, in the Far East and Moscow-Simferopol in the Crimea.

Double-tracking of the old, trans-Siberian air route became a reality last summer when four-turboprop An-10As and Il-18s began flying from Moscow to Khabarovsk via Syktyvkar, Norilsk and Yakutsk. This northerly route, which juts above the Arctic Circle at Norilsk, trims air distance between Moscow and Yakutsk by more than 600 mi. It permits cutting over 1,000 mi. from the USSR's longest air route, between Moscow and Petropavlovsk.

In December, Aeroflot made its first Il-18 proving flight over another trans-Siberian route penetrating ever farther into the Arctic. This link runs from Moscow to Magadan on the Sea of Okhotsk, with a single stop at Tiksi, on the Laptev Sea east of the Lena river's mouth.

On about the same latitude as Point Barrow, Alaska, Tiksi is 1,300 mi. north of a corresponding point on the southern trans-Siberian air route which runs through Sverdlovsk, Omsk, Novosibirsk, Krasnoyarsk, Irkutsk, Chita and Magdagachi to Khabarovsk and Vladivostok.

Skirting the Weather

When the southern link was the only one available, bad weather forced Aeroflot to halt trans-Siberian operations for days at a time during winter. Now, with three widely-paced airways to fly on, the Soviet carrier expects at least one trans-Siberian route to be open at all times.

Aeroflot anticipates its most spectacular improvement in trans-Siberian service early in 1961, when four-turboprop Tu-114s—the world's largest transports—are to begin flying nonstop from Moscow to Khabarovsk, about 4,300 mi. Such flights were originally slated to start in 1958 but have been postponed repeatedly without explanation.

Internationally, the Soviet carrier extended its operations to few new points last year, and there was little indication of the explosive foreign route expansion that is certain to come. But existing service was upgraded sharply.

Looking into the future, Aeroflot Chief Loginov declared that the Soviet Union "will not be tardy" in the development of supersonic commercial aircraft.

Aeroflot carried out its promise to provide a major expansion on helicopter routes during 1960. Goal was to increase the helicopter system to nearly 7,500 route miles—10 times as many as in 1959—and to inaugurate 100 new links.

Helicopter Network

Most extensive helicopter service is in the Moscow area. During 1960, 10-passenger, single-rotor Mi-4s began regular flights from the Russian capital's central area to Vnukovo, Sheremetyevo and Bykovo Airports and also interconnected each of these fields. Initial flight frequency from Frunze Central Airport, near downtown Moscow, to Sheremetyevo International Airport was 10-12 round trips daily.

Another major helicopter hub is the Azerbaidzhan capital of Baku on the Caspian Sea. During the last half of 1960, Mi-4s made 3,000 flights and carried 30,000 passengers over the 60-mi. route between Baku and Neftyanye Kamni, an oil-producing center built on pilings over reefs in the Caspian.

During 1960, strong complaints appeared in the Soviet press that "the ground was not keeping up with the sky" in Aeroflot's operations. There were frequent charges of inexcusable flight delays, inadequate airport facilities, and discourteous attitudes toward passengers.

IL-18 engine open for inspection.

Aeroflot was reported working on these problems, too. In Moscow, Sheremetyevo Airport was designated as the capital city's international field, relieving some of the overcrowding at Vnukovo.

Along with its gains, Aeroflot suffered some major setbacks last year. More accurately, difficulties which had previously been concealed by censorship became embarrassingly apparent.

Almost at the same time that Aeroflot was flexing its muscles by rushing a small fleet of Il-18s and numerous piston powered Il-14s to the Congo in a spectacular 6,800-mi. airlift of Communist personnel, equipment and food, the Soviet carrier was forced to admit that the workhorse of its turboprop fleet had serious technical problems.

Until the Kiev crash, Russia had hailed the Il-18, whose designers won a 1960 Lenin Prize, as the perfect answer to its urgent need for a fast, reliable turboprop which could be operated at a far lower ton-mile cost than the fuel-hungry Tu-104s.

Yet it appears that Aeroflot knew for some time that the Il-18 was ailing.

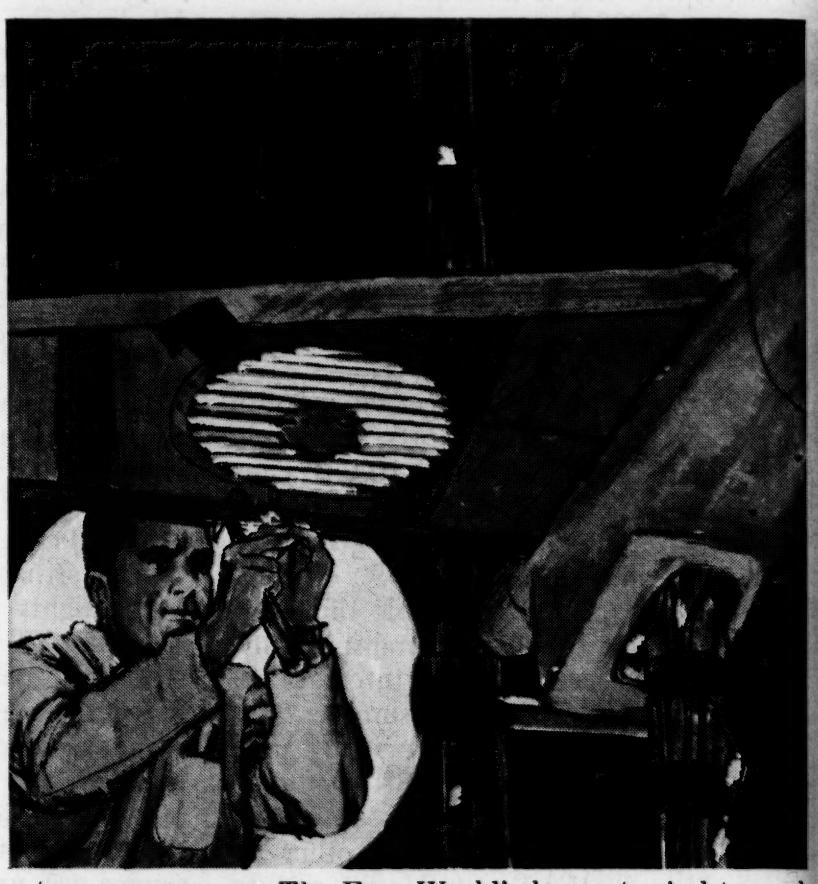
The Il-18 underwent a long break-in period of all-cargo flights. But when it entered regular passenger service in 1959 it was at first withheld from long-haul operation on the trans-Siberian route. Regular trans-Siberian service began only after persistent inquiries appeared in the Soviet press asking why the Il-18 was being kept from flying a

This is systems capability a

Assembled at the Columbus Division of North American Aviation are the facilities and the proven technical intellect to bring original concepts swiftly to practical production by the most economical and efficient methods. Here, in one of the most complete centers of advanced systems technology in the world, many of the important advances in electronic, electromechanical, and environment systems, as well as other areas, have been made. This is true systems capability ... this is the Columbus Division.

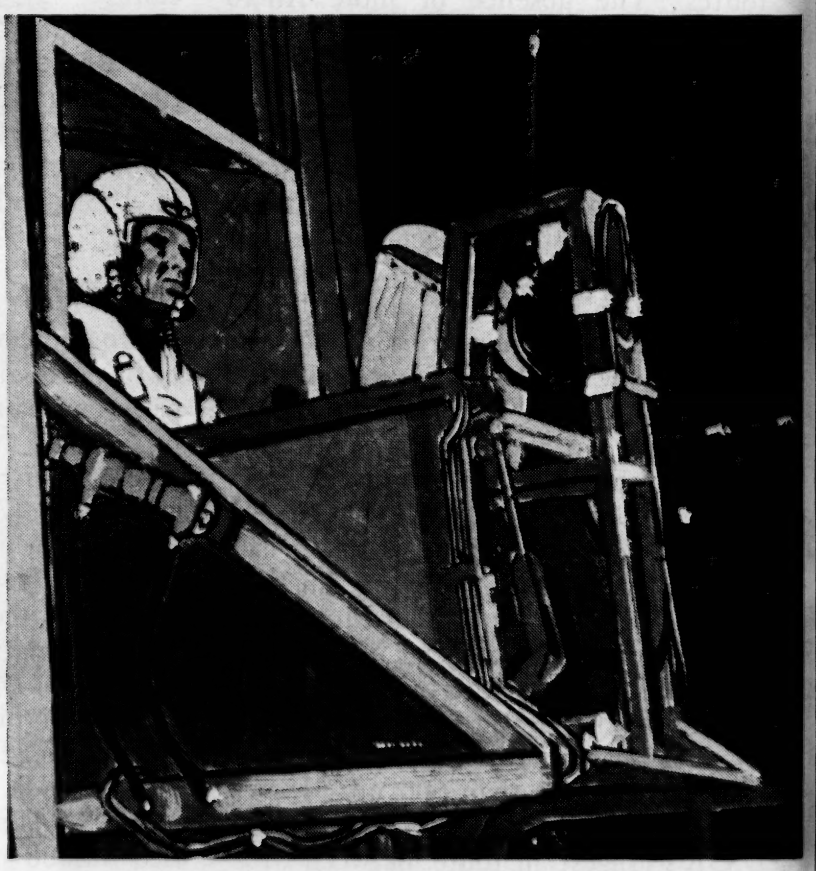
THE COLUMBUS DIVISION OF NORTH AMERICAN AVIATION, INC.

Columbus, Ohio



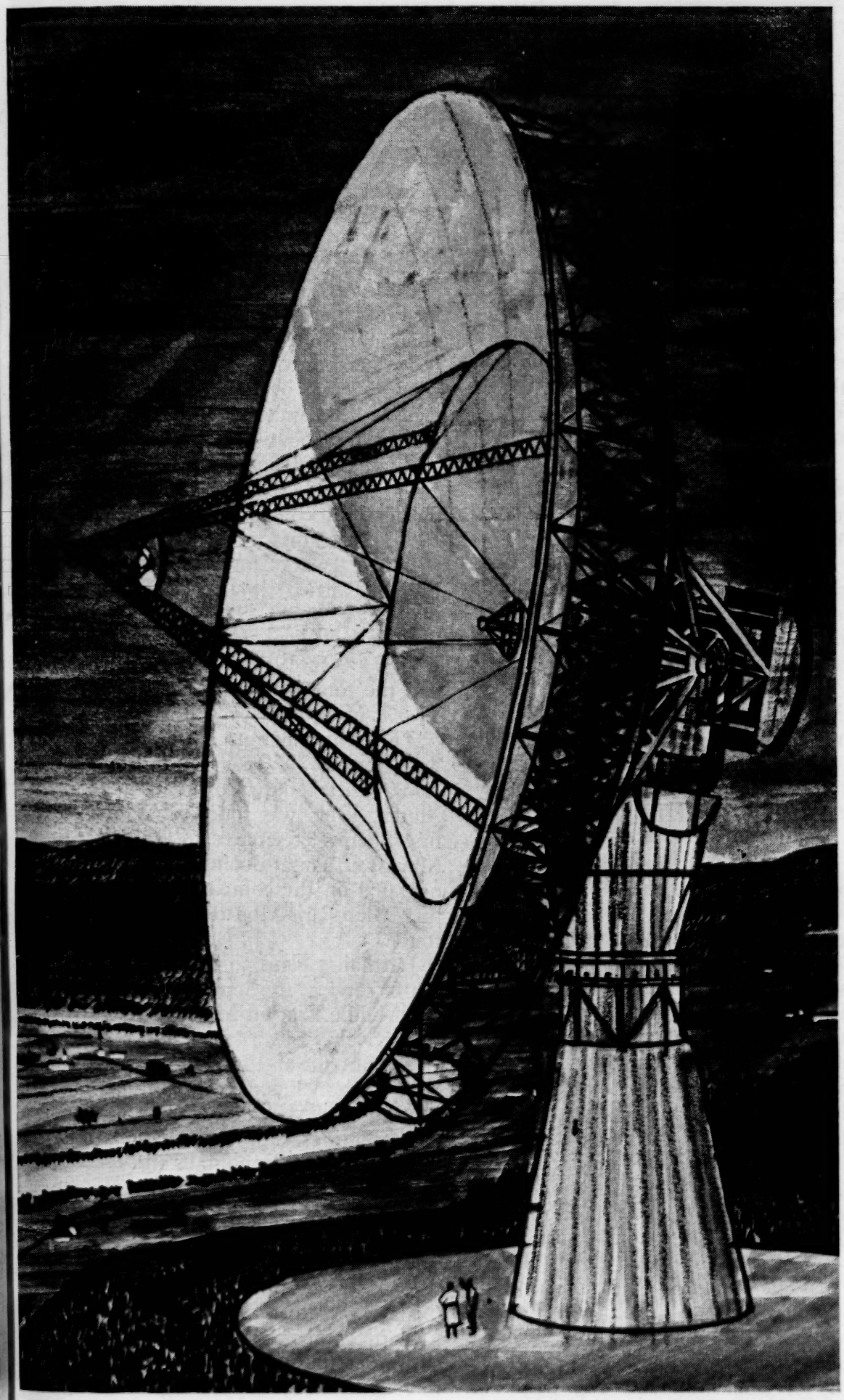
V/STOL FACILITIES. The Free World's largest wind tunnel for the study of transition from vertical to level flight is a part of the facilities at Columbus. Other V/STOL equipment includes six-degree-of-freedom flight simulator, and zero-altitude, zero-speed escape systems.

HIGH OR LOW. The Mach 2 A3J Vigilante, now being built for the Navy at Columbus, operates effectively at deck level or up in the stratosphere. The versatile A3J can perform either attack or interception missions in any weather, at any attitude or altitude, day or night.



"G" SEAT. Columbus developed unique "G" seat to study human tolerance to a high degree of vertical acceleration, and to mate human factors to the machine. Advanced low-level high-speed escape systems and pilot response in these flight regimes will be studied with it.

at NAA-Columbus



RADIO/RADAR ANTENNAS. An advanced type of antenna, constructed to such precise tolerances that it will be tuned to exact pitch, will be built by NAA-Columbus for the Air Force on "Haystack Hill" near Tyngsboro, Mass. Unique design developed at Columbus allows the rigid specifications to be met with significant reductions in dead weight, and in control power requirements.

route on which its publicized capabilities would show to best advantage.

The Il-18 isn't Russia's only commercial aircraft headache. The entire family of transports unveiled in 1957 apparently has had far more bugs than the Soviets care to discuss.

Where is the Tu-114?

The 120-220 passenger Tu-114 made big headlines and swelled Soviet pride. But it performed no service for the Russian airline passenger during its first three years of flying.

Its long-range capabilities were demonstrated in non-stop flights between Moscow and New York and Moscow and Washington. Last March and April the aircraft set 24 world records by carrying a 25 metric ton payload over closed courses of 1,000, 2,000 and 5,000 km. at speeds of 541.13 mph., 532.369 mph. and 544.749 mph., respectively.

It was known that the Rossiya had trouble with gear boxes that transmit power from the 12,000-shp. turboprop engines to the contrarotating propellers. Soviet sources also conceded that the Tu-114's ground servicing problems are proportional to the aircraft's huge size. Special loading and unloading equipment and airport tugs are required.

The An-10, first displayed to the public early in 1957—several months before the Il-18—also has had its problems. The Russians have never praised this airplane as highly as the Il-18, and Il-18s have been placed on some routes which had originally been designated for An-10s.

Criticized for its bulky-looking configuration as soon as it appeared, the An-10 was plagued by stability problems during its test period, experienced several near crashes, and required modification of its tail assembly before going into regular service in the summer of 1959.

The four-jet Tu-110, unveiled at the same time as the Il-18, was never put into production. The twin-turbine, 80-passenger, 70,000-lb. gross weight Mil Mi-6 helicopter, hailed for its commercial potential when first shown in 1957, had not been used for regular passenger service by the end of 1960.

Prestige Transport

Meanwhile, the Tu-104, regarded as a prestige transport, carried on last year as Aeroflot's only turbojet transport in scheduled service. Besides exorbitant fuel consumption, the aircraft suffers from poor utilization.

Concerned over the Tu-104's hot landing characteristics, Aeroflot revealed last fall that it was investigating the possibility of providing reverse thrust to improve its safety margin when stopping on wet, snowy or icy runways.

● AIR TRANSPORT

World Airlines Feel Full Jet Impact

Most international airlines around the world marked their entry into the long-range turbojet race in 1960. Fleets of Boeing and Douglas jet aircraft were delivered and the scramble to fill the new capacities was on.

The jets are expected to reshape travel patterns around the world, opening new areas to tourist business. As the struggle for routes and rights increases, large questions remain as to whether enough new traffic will develop alongside the new capacities, and whether new means may be employed to divide the traffic that does develop.

Among the highlights of airline activity around the world were these:

Great Britain

British Overseas Airways Corp. returned to South America last year with de Havilland Comet 4 jet service to Santiago, Chile. Another highlight was introduction in May of Boeing 707-420 service on the New York-London route.

Provisional year-end figures indicate a 1960 increase of 26% in capacity ton-miles offered, to 530 million; a 29% increase in passenger miles to 2,352 million; an 8% rise in freight ton miles to 43 million and an overall passenger and freight load factor of 57%.

BOAC had received its entire initial order of 15 Boeings by year-end and the airplanes were serving a number of points within the U.S. and Canada. Comets formerly used on the Atlantic were used to increase services on Far Eastern routes, particularly South Africa, Australia and India. New Bristol Britannia turboprop services were introduced. Transatlantic freight services were flown with two converted Douglas DC-7Cs. BOAC, permitted to retain its DC-7C fleet, reports a high utilization of these aircraft in charter flights. The government originally specified their immediate sale when delayed Britannias were delivered.

British European Airways reported a 1960 traffic growth about 14% above the world average. But, with delay in introducing the Vickers Vanguard a factor, net profit dropped from $5.6 million to $4.2 million.

BEA offered 229 million capacity ton miles last year, selling 66% of this capacity. Capacity offered increased 21%, passenger miles flown rose 20% to 1,352 million, and freight ton miles 20% to 17 million. Capacity ton miles per employe increased 12% to 17,700.

The airline introduced Comet 4B service last year on Eastern Mediterranean routes. Vanguard services are now operated with six of the aircraft and the fleet of 20 Vanguards is expected to be in service by the end of this year. The Comet fleet now totals seven aircraft, with three more scheduled for delivery this year and four more to follow.

By midsummer, the Vanguards and Comets are expected to have boosted BEA capacity by 20% over last year's figure.

The Netherlands

KLM Royal Dutch Airlines, with 12 Douglas DC-8s scheduled to be on hand by June, plans to boost its jet route mileage to 17.5 million mi. this year from 4.7 million mi. for 1960.

DC-8 service will be introduced on the carrier's mid-Atlantic and polar routes and on flights to Johannesburg, South Africa.

Revenue figures for 1960 are being delayed pending a formal stockholders meeting, but officials say the airline will pay a dividend approximately 5% higher than that voted for 1960.

The airline carried approximately 1,360,000 passengers over its route system last year compared with 1,104,000 in 1959. Mail deliveries were boosted from a total of 3,192 tons in 1959 to 3,640 tons in 1960; freight from 31,178 to 37,400 tons.

KLM is in the market for a mid-range jet transport and best bets seem to be either, or both, the Convair 990 and the Boeing 727. It also has been considering joining the maintenance and route consortium of Scandinavian Airlines System and Swissair for the past year. All three carriers now fly the DC-8, and the fact that SAS and Swissair plan to put the 990 in service this year could encourage KLM to place a similar order.

Impact of the Congo airlift last July during the initial uprising against the European, in which all five of Sabena's 707-320s were used to evacuate civilians and fly in Belgian troops over a 20-day period, plus the disruption of its profitable route structure in the area are still being evaluated, and revenue and passenger figures for 1960 have not yet been released. The potential loss, however, could be substantial.

The 707s were pulled primarily from the lucrative transatlantic run at a time Sabena was realizing an average load factor of 65% on 11 direct roundtrip flights per week between Brussels and New York.

On a longer-range, more crippling basis, Sabena has traditionally looked to its routes to and within the Congo to provide approximately 40% of the carrier's annual revenue. Just how Sabena will eventually fare in the Congo is still in doubt, but its future in this area looks far from promising.

To add to its problems, Sabena suffered a further blow last month when one of its five 707s plowed into a field near Brussels Airport after a flight from New York, killing a total of 73 persons.

West Germany

Lufthansa German Airlines' results in 1960, the carrier's fifth full year of operation since its post-war rebirth, show an approximate 40% increase in gross revenue over 1959. The airline expects this increase to enable it to reduce by about $6 million its $10 million 1959 deficit.

With 1,237,629 passengers carried during 1960 compared with 786,626 in 1959, Lufthansa passed the million-passenger mark for the first time. Freight carried totaled 16,340 tons, mail 4,545 tons.

Passenger load factor was boosted from 54% in 1959 to 59.5% last year and the total load factor from 54% to 57.6% in 1960.

The introduction of Lufthansa's first Boeing 707-420s on the airline's transatlantic route to New York in March, 1960, was followed in May by first Boeing jet services to Chicago. In May, Lufthansa Boeing 707-420s also operated on the company's new Frankfurt/Main-Paris-Montreal-San Francisco route.

Lufthansa plans to introduce Boeing 720B service to South America and the Middle East on May 20 and July 1 respectively.

At the end of 1960, Lufthansa's aircraft fleet included: 4 Boeing 707 jet transports, 7 Lockheed 1649A Super Constellations, 9 Vickers Viscounts, 9 Convair 440 Metropolitans and 2 Lockheed 1649A Super Constellations converted into cargo carriers.

Switzerland

Swissair, awaiting the arrival of the Convair 990 to draw abreast of its Far Eastern competitors who already have converted to turbine equipment, plans to roughly double its jet route mileage network by November—boosting it from the present 32,200 mi. to 62,100 mi.

The airline hopes to receive the first two of seven 990s on order in

JAPAN AIR LINES' DOUGLAS DC-8

time to place them on its Far Eastern and South American routes sometime between Aug. 15 and Sept. 15. Feeling the competitive pinch from other carriers which began jet operations to the Far East a number of months ago, Swissair originally had planned to have the 990s in operation by this summer. However, delays in the Convair test program resulted in a stretchout of delivery dates.

Despite this competition and the fact that a fuel deficiency on the DC-8 placed it at a competitive disadvantage on the transatlantic run, Swissair realized a profit for 1960. The earned surplus, however, declined to approximately $1.2 million as opposed to $1.8 million in 1959.

Passenger total for the year was 1,303,225 compared with 1,106,251 in 1959, but the over-all load factor declined from 61.1% to 58.6% in 1960.

Italy

Alitalia this year plans to extend its jet route structure beyond the present Far Eastern terminal at Bombay to Sydney, Australia. Extension, expected to be inaugurated by late spring, probably will be made on a pool basis with the French airline, Transports Aeriens Intercontinentaux.

With its DC-8s and Sud Caravelle medium-range jet transports in service for the first time last year, Alitalia boosted its available seat miles by 25.2% and carried a total of 1,099,668 passengers, a gain of 29.4% over the 849,644 carried in 1959.

Passenger load factor for the year was 57.7%, a 2.9% gain over the 1959 figure of 56.1 Over-all load factor was 55.6 % as opposed to 54.6% in 1959.

New flights inaugurated last year included a Rome-Milan-London-Boston-Montreal-New York schedule introduced last March on a twice-weekly basis with Douglas DC-7Cs that were replaced in July by the DC-8; twice-a-week Viscount service between Rome, Milan and Prague, and three Caravelle flights between Rome, Athens and Cairo each week.

As in the case of several airlines, Alitalia is feeling the maintenance pinch caused by the necessity of keeping many types of aircraft in the air. Alitalia presently is operating eight specific models, including five piston-engine aircraft ranging from the DC-3 to the DC-7C, one turboprop and two jet transports.

The airline moved into new headquarters and maintenance facilities early this year with the transfer of Rome airline operations from Ciampino to the new Fiumicino airport.

Spain

Iberia Air Lines of Spain is introducing Douglas DC-8 jet transports on its Atlantic network June 1. Initially, the carrier will offer three non-stop flights from New York to Madrid and one weekly non-stop flight from New York to Lisbon, continuing to Madrid. DC-8 service will be extended to Latin America in July.

Seating capacity of Iberia's DC-8s in mixed first and economy classes is 120 passengers.

Iberia recently ordered four Sud Caravelle VIRs, and took an option on four more.

The airline showed appreciable increases in all categories of its operations last year. Gross revenue was $26,957,352, up from $20,225,157 in 1959. Total hours flown were 72,892 or 5% over the 64,612 hr. flown the previous year. Passengers carried numbered 955,974 compared with 831,929 in 1959; miles flown totaled 14,334,997, an increase of about 12% the previous year. Iberia carried 1,898 tons of mail and 5,250 tons of cargo in 1960 for substantial gains in both categories.

Scandinavia

Scandinavian Airlines System, whose equipment costs, depreciation losses and efforts to increase its international route complex resulted in an over-all loss of approximately $16.8 million during the past fiscal year, expects to suffer a loss again this year.

Introduction of seven Douglas DC-8 jet transports on the transatlantic and 13 Sud Caravelles on European and Far Eastern routes boosted revenue traffic for the year by more than 16%. Total airline production increased 15% over the previous year, and cargo and mail tonnage were boosted substantially.

This added productivity, however, was not enough to offset the costs of switching to jet operations while still maintaining an active piston fleet and the resultant high maintenance costs, plus the depreciation in value of its older aircraft and investments abroad to expand its system.

These included a cooperation pact with the Mexican airline, Guest Aerovias Mexico, and the establishment of Thai Airways International, Ltd. in agreement with Thai Airways Co., Ltd.

The Convair 990 is scheduled to enter service with SAS late this summer or early fall, but the airline estimates that it will still need to retain certain Douglas DC-7C services.

The airline says it believes that the continued transition "is expected to produce an unfavorable economic result during the current fiscal year" which ends on Sept. 30.

In an effort to offset these losses, the airline plans to boost its available seat miles by 22% when its summer schedule becomes effective on Apr. 1. Service will include up to 7,600 available seats each week on its DC-8 flights between Europe and the U. S., while the Caravelles will fly into 32 cities in Europe and the Middle East. When it

arrives, the Convair 990 will be placed in service on routes to South America, the Far East and Africa.

India

Air-India hopes to get a Tokyo-New York route through bilateral talks expected this spring between the United States and India and has geared its operations for around-the-world service.

Entry of the airline into New York last May with Boeing 707-420 turbojet transports raised its year-end traffic volume to 100,000 passengers. Three Boeing 707s now being flown logged a daily utilization rate of 10.8 hr. on a flight schedule of three weekly trips between Bombay and New York, via London, plus two direct Bombay-London flights.

Air-India is expected to increase this frequency with the acceptance of a fourth Boeing sometime next month and has also been negotiating with its more 707s so as to begin phasing out government for the purchase of two its piston-engine fleet of nine Lockheed L-1049s. The retired aircraft will probably be placed into service on Indian Airways, the internal carrier of India.

During the year, Air-India made maximum use of revenue pooling arrangements with other flag carriers: British Overseas Airways Corp. and Qantas Empire Airways for services to the U. S., Australia and Japan, Aeroflot for service to Moscow, and Czechoslovakian Airlines for service to Prague. Similar maintenance pools also have been arranged on a global basis for the exchange of spare parts and tools with all operators of Boeing aircraft.

South America

Chief problem throughout South America during 1960 continued to center around the passenger fare issue. Despite a major conference of most South American governments and several meetings of air carriers operating in the area in moves to resolve the rate question, rate-cutting continued to be as rampant as it had been before official attempts to establish some standards were made.

Although the International Air Transport Assn. had adopted a rate schedule which had the unanimous support of IATA members, most carriers were unwilling to bind themselves to a fare structure that very likely would be undermined by fare slashes of non-IATA carriers.

In one attempt to encourage conformity with fare standards, "underdeveloped carriers" were allowed to sell tickets at a rate 10% below the IATA fare levels. As such carriers acquired more modern equipment that generally matched that of the major airlines, they refused to relinquish the 10% exemption, leading most carriers to make similar cuts to remain competitive.

In some areas, a 40% discount on tickets sold has been in practice for a number of years and still remains in effect. Some Latin American airlines have confined operations to the most profitable routes to provide them with a healthy load factor that permits a 20% fare discount. A Peruvian airline is offering a 10% discount to all citizens of Peru.

Japan

Japan Air Lines, held back during most of 1960 in its transpacific operations because of the lack of jet aircraft, has plans for rapid expansion this year. In 1960, the carrier's international passenger miles totaled 289 million, up from 249 million in 1959. Estimate for 1961 is 477 million international passenger miles. Domestically, passenger miles rose from 215 million to 277 million; 1961 estimate is 347 million.

The airline will end its fiscal year this month with a profit of about $700,000, largely due to steadily increasing traffic on its domestic routes.

JAL received its first four Douglas DC-8s between August and December of last year. A fifth DC-8, scheduled for delivery in May, will be used to initiate flights to Europe on a polar route. Transpacific flights will be increased to nine weekly—four through San Francisco, three through Los Angeles, and two through Seattle.

The first of three Convair 880-22M jets will be delivered this summer and are scheduled to go into service to Hong Kong and Southeast Asia, providing all-jet service on these routes. An additional two 880s have recently been ordered for early 1962 delivery.

A pool agreement signed last year with Air France for polar flights has been extended. Other JAL plans include extending its Southeast Asia route now terminating in Bangkok on across Southern Asia to London. This proposal faces difficulty in securing rights through some of the countries involved. The airline also wants rights beyond the U.S. West Coast to New York and on across the North Atlantic for a round-the-world service.

Japan's second carrier, All-Nippon Airways, which now flies only domestic routes but seeks to enter the international field, increased its sales 180% last year, now flies about 40,000 passengers a month.

France

France's four international carriers all reported higher passenger and freight loadings during 1960.

State-owned Air France, despite the late-year strike of Boeing 707 pilots that lasted for several weeks, reported passenger-kilometers were up 17.5% from 1959, totaling 4,290,000,000. By 1960 yearend, Air France was operating all 17 of its Boeing 707 Intercontinentals originally ordered, as well as 24 Caravelles. This year, the state airline will add an additional nine Caravelles. Finally, in 1962, the company will take delivery of three additional Boeings, bringing its total jet fleet to 50 aircraft. Air France recently added Boeing equipment on its Paris-New York-Mexico City run, thus completing transition from piston to jet on all major routes.

Air Algeria, next-largest French carrier in terms of passenger loads, continued to benefit from high levels of traffic between Algeria and France because of the Algerian conflict. The carrier last year hauled 600,000 passengers, of which 22% were carried in the carrier's four Caravelles.

The third largest French airline, Union Aeromaritime de Transport (UAT), whose routes mainly link Paris with Africa, reported a slight increase in passenger traffic to 201,000 passengers. During 1960 UAT began operating its jet fleet of two Douglas DC-8s on the African run.

Transports Aeriens Intercontinentaux (TAI), France's fourth international airline, also privately-owned, began operating its first DC-8 on its Far Eastern and African routes. The company recently took delivery of its second DC-8. A third DC-8 is slated for early summer delivery. TAI expects to begin through DC-8 service between Paris and Los Angeles in May.

Czechoslovakia

CSA Czechoslovak Airlines hopes to increase its capacity this year by one third over 1960, when it carried a record total of 750,000 passengers.

Passenger ton miles flown during 1960 totaled 20,777,580; cargo ton miles 3,765,105. Overall 1960 ton-mile performance was 30,217,123.

During the same period, the Czech carrier extended its route network by 10,246 mi. to the present total of 26,746 mi. The airline operates Tu-104s, Il-18s, Il-14s, an Il-12, L200 Moravas and Aero 45s.

CSA also is pushing ahead with a redevelopment program for Prague-Ruzyne Airport, the airline's home base, scheduled to be completed by 1965. A year ago most of the airport's outdated buildings were replaced by a new control tower and modern administration and passenger reception facilities (AW Oct. 17, p. 47).

At present, some 20 international airlines serve the Czech capital. CSA Czechoslovak Airlines operates regular scheduled services from Prague-Ruzyne to about 30 different capitals in Europe, the Middle East, Far East and Africa. More than two-thirds of its domestic route network is also served from Prague-Ruzyne.

U. S. Missiles

	GENERAL				STATUS				AIRFRAME					POWERPLA	
Category	Missile name	Military designation	Cognizant service	Prime contractor	Research	Development	Production	Service Use	Manufacturer	Over-all length	Over-all span, wings or fins, ft.	Body diameter, ft.	Launching wt.	Manufacturer	No. of engines
Air-to-Air	Eagle	AAM-N-10	Navy	Bendix	√	√	..	..	Grumman	12	....	1.2	1,300	Aerojet-General	2
	Falcon	GAR-1, 2, 3, 4, 9, 11	USAF	Hughes	..	..	√	√	Hughes	65	1.8	0.5	100	Thiokol	1
	Genie	MB-1	USAF	Douglas	..	..	√	√	Douglas	8	....	....	900	Aerojet-General	1
	Sidewinder 1A	AAM-N-7	Navy	BuWeps	..	..	√	√	.....	9	....	0.4	155	Naval Prop. Plant	1
	Sidewinder 1C	.....	Navy	Philco	..	√	√	..	.....	....	....	....	.....	.....	..
	Sparrow III	AAM-N-6	Navy	Raytheon	..	√	√	√	Raytheon	12	3.3	0.7	400	Aerojet-General	1
	Wagtail RFM-3/-7	.....	USAF	Honeywell	..	..	√	..	Honeywell	....	....	....	.....	Thiokol	1
Air-to-Surface	Bullpup	ASM-N-7-GAM-83A	Navy/USAF	Martin	..	..	√	√	Martin	11	3	1	571	Thiokol	1
	Bullpup B	ASM-N-7B-GAM-83B	Navy/USAF	Martin	..	√	..	..	Martin	....	....	....	.....	Hercules	1
	Corvus	YASM-N-8	Navy	Temco	..	..	√	√	Temco	....	....	....	.....	Thiokol	..
	Hound Dog	GAM-77	USAF	NAA	..	..	√	√	NAA	42.5	....	2.3	10,000	P&W	1
	Quail	GAM-72	USAF	McDonnell	..	..	√	√	McDonnell	10	7	1.5	1,100	G.E.	1
	Rascal	GAM-63	USAF	Bell Aerosystems	..	..	..	√	Bell Aerosystems	32	....	4	.....	Bell Aerosystems	3
	Skybolt	GAM-87A	USAF	Douglas	√	√	..	..	Douglas	38.5	....	....	9,000	Aerojet-General	2
	Wagtail RFM-5/-6	.....	USAF	Minn. Honeywell	√	..	..	..	.....	....	....	....	.....	Naval Prop. Plant	1
	Zuni	.....	Navy	.....	..	..	√	√	Norris Thermidor	9	2.3	0.4	105	Naval Prop. Plant	1
Anti-Submarine	Able	.....	Navy	Avco	..	..	√	√	.....	8.5	....	1.1	500	Naval Prop. Plant	1
	Asroc	.....	Navy	Minn. Honeywell	..	√	√	√	Minn. Honeywell	15	2.5	1	930	Navy/Honeywell	1
	Astor	.....	Navy	Westinghouse	√	√	..	..	.....	20	....	....	.....	.....	..
	Subroc	.....	Navy	Goodyear	√	√	..	..	Goodyear	....	....	....	.....	Thiokol	..
Surface-to-Air	Bomarc	IM-99A	USAF	Boeing	..	√	√	√	Boeing	47	18.2	3	16,000	Marquardt	2
	Bomarc	IM-99B	USAF	Boeing	..	√	√	√	Boeing	47	18.2	3	16,000	Marquardt	2
	Hawk	XM-3	Army	Raytheon	..	..	√	√	Nortronics/Raytheon	17	4	1.2	1,250	Aerojet-General	1
	Mauler	.....	Army	Convair (Pomona)	√	√	..	..	Convair	....	....	....	.....	GCR	..
	Nike Ajax	SAM-A-7	Army	Western Electric	..	..	√	√	Douglas	21	....	1	2,600	Aerojet-General	1
	Nike Hercules	SAM-A-25	Army	Western Electric	..	..	√	√	Douglas	27	....	2.5	10,000	Thiokol	1
	Nike Zeus	.....	Army	Western Electric	..	√	√	√	Douglas	60	....	....	20,000	GCR/Thiokol	3
	Redeye	.....	Army/Navy	Convair/ARGMA	√	√	..	..	.....	4	....	0.25	20	.....	..
	Talos	SAM-N-6	Navy	Bendix	..	..	√	..	McDonnell	20	....	2.5	3,000	McDonnell/Hercules	1
	Tartar	.....	Navy	Convair	..	√	√	..	Convair	15	....	1.5	1,500	Aerojet-Gen./Hercules	1
	Terrier	SAM-N-7	Navy	Convair	..	..	√	√	Convair	15	....	1.5	3,000[1]	Atlantic Research/Hercules	1
	Davy Crockett	.....	Army	.....	..	√	..	..	.....	....	....	....	.....	.....	..
Surface-to-Surface	Atlas	SM-65	USAF	Convair	..	√	√	√	Convair	82+	16	10	260,000	Rocketdyne	3
	Clam	.....	USAF	.....	√	..	..	..	.....	....	....	....	.....	.....	..
	Slam	.....	USAF	.....	√	..	..	..	.....	....	....	....	.....	Marquardt	1
	Cobra	.....	USMC	Daystrom	√	√	√	..	Daystrom	2.6	1.1	0.3	20	.....	2
	Corporal	SSM-A-17	Army	Firestone/Gilfillan	..	..	√	√	Firestone	46	....	2.5	12,000	Ryan	1
	Honest John	M-31	Army	Em. Elec./Douglas	..	..	√	√	Em. Elec./Douglas	27	8	2.5	6,000	Hercules	1
	Honest John (Imp.)	XM50	Army	Em. Elec./Douglas	..	..	√	..	Douglas	25	4.5	2	.....	Hercules/Em. Elec.	1
	Jupiter	SSM-78	Army/USAF	Chrysler	..	..	√	√	Chrysler	60	....	9	110,000	Rocketdyne	1
	Lacrosse	SSM-A-12	Army	Martin	..	..	..	√	Martin	19.2	9	1.7	2,300	Thiokol	1
	Law	XM-72	Army	Hesse-Eastern	√	..	..	..	Hesse-Eastern	....	....	....	.....	Hesse-Eastern	1
	Little John	XM-51	Army	ABMA	..	..	√	√	Em. Elec.	15	2	1	980	Hercules	1
	Lobber	.....	Army	Convair	..	√	..	..	Convair	9	....	....	.....	.....	1
	Mace	TM-76	USAF	Martin	..	..	√	√	Martin	44	22.9	4.5	14,000[1]	Allison	1
	Matador	TM-61	USAF	Martin	..	..	..	√	Martin	40	29	4.5	12,000	Allison	1
	Minuteman	WS-133A	USAF	Boeing	..	√	..	..	Beech/Boeing	57	....	5.5	65,000	Thiokol, Aerojet, Hercules	3
	Pershing	.....	Army	Martin	√	√	..	..	Martin	34	....	3.4	30,000	Thiokol	2
	Polaris	FBM	Navy	Lockheed	..	..	√	√	Lockheed	28	....	....	28,000	Aerojet-Gen./Hercules	2
	Redstone	SSM-A-14	Army	Chrysler	..	..	√	√	Chrysler	69	....	6	61,000	Rocketdyne	1
	Regulus II	SSM-9-A	Navy	Chance Vought	..	..	..	√	Chance Vought	57	20	....	22,000	GE	1
	Sergeant	.....	Army	Sperry	..	√	√	..	Sperry	34	6	3	30,000	Thiokol	1
	Shillelagh	.....	Army	Aeronutronics	..	√	..	..	.....	....	....	....	40	.....	1
	Snark	SM-62	USAF	Northrop	..	..	√	√	Northrop	67	42	15	50,000	P&W/ABL	1
	Thor	SM-75	USAF	Douglas	..	..	√	√	Douglas	62	....	8	110,000	Rocketdyne	1
	Titan	SM 68	USAF	Martin	√	√	√	..	Martin	98	....	10	222,000	Aerojet-General	3
	Titan II	SM 68-B	USAF	Martin	√	√	..	..	Martin	108	....	10	.....	Aerojet-General	3

Abbreviations:
ABL — Allegheny Ballistics Labs.
ABMA — Army Ballistic Missile Agency
AC — AC Spark Plug
ARGMA — Army Rocket & Guided Missile Agency
ATRAN — Automatic Terrain Recognition
BuWeps — Bureau of Weapons
Em.Elec. — Emerson Electric
GCR — Grand Central Rocket Co.
GE — General Electric
GFE — Government Furnished Equipment
IRB
I
MI
NOT

POWERPLANT				GUIDANCE		PERFORMANCE		REMARKS
	No. of engines	Engine designation	Rated thrust, lb.	Manufacturer	Type of guidance	Maximum Mach. number	Maximum range, n. mi.	
	2	spr.	.....	Bendix	Active radar homing	4	100	Nuclear warhead; for subsonic aircraft platform.
	1	spr.	.....	Hughes	Semi-active homing/infrared	.....	.....	GAR-1 & 3 use radar, 2 & 4 infrared; GAR-9 will have longer range and nuclear capability.
	1	spr.	.....	.....	Unguided	.....	1.5	Nuclear warhead; completing test program.
	1	spr.	.....	Philco/G.E.	Infrared	.....	2	Developed by NOTS; GAR-8 is USAF version.
.....	..	.....	.....	Philco	Infrared	.....	.....	Under dev. at NOTS. More speed & range.
	1	spr.	.....	Raytheon	Semi-active radar homing	3+	.....	All weather, all aspect capability
	1	lpr.	.....	Honeywell/Bendix	Inertial	.....	.....	Air defense.
	1	lpr.	.....	Martin	Command	1.8	3+	Movable canard surface.
	1	spr.	.....	Martin	.....	.....	.....	
	..	lpr.	.....	Texas Instr./W. L. Maxson	.....	1+	.....	Stand-off missile; pre-packaged lpr. engine.
	1	J52 tj.	7,500	Autonetics	Inertial	1+	500+	For B-52G.
	1	J85 tj.	2,500	.....	Gyro auto pilot	0.9	200	Diversionary decoy for B-47.
	3	lpr.	12,000	Bell Aerosystems	Radar command	1.5	100	Developed for B-47—Terminated.
	2	spr.	.....	Nortronics	Inertial: star tracking	.....	1,000	GE ablation nose cone; air-launch ballistic missile.
	1	spr.	.....	Honeywell	Inertial	.....	.....	
	1	spr.	.....	.....	Unguided	2+	5+	Folding fin all-weather rocket.
	1	spr.	.....	.....	.....	.....	var.	Fired from gun launchers.
	1	spr.	.....	.....	Unguided	.....	.....	Comb. missile, torpedo and depth charge.
.....	..	.....	.....	.....	.....	.....	.....	
	..	spr.	.....	Kearfott/Librascope	.....	.....	.....	Fired through torpedo tubes.
	2	RJ43-MA-3	10,000	Westinghouse	SAGE/active radar homing	2+	250	Aerojet Gen. liq. prop. booster.
	2	RJ43-MA-11	.....	Kearfott/Westinghouse	SAGE/active radar homing	2+	400	Solid prop. booster.
	1	XM22E8 spr.	.....	Raytheon	Semi-active radar homing	.....	22	Eff. at low & int. alt. Mobile or fixed site.
	..	spr.	.....	Burroughs/Raytheon	Radar	.....	.....	Self-contained weapon.
	1	lpr.	2,600	Western Electric	Command	.....	25	Spr. booster by Hercules.
	1	spr.	.....	Western Electric	Command	.....	75+	Four 14.5 ft. Ajax spr. boosters. G.E. warhead.
	3	spr.	.....	Western Electric	Command	.....	75+	Sperry target track. & disc. radar trans.
.....	..	.....	.....	Philco/Convair	Infrared	.....	.....	Shoulder-fired bazooka-type air defense.
les	1	rj.	.....	Sperry	Beam rider/semi-active hom'g	2+	65+	Also surface-to-surface. spr. booster.
ules	1	spr.	.....	Raytheon	.....	1+	10	Dual thrust motor.
/Hercules	1	spr.	.....	Sperry	Beam rider	2.5	10	Imp. version inc. range to 20 miles.
.....	..	.....	.....	.....	.....	.....	.....	Man transportable tactical nuclear weapon.
	3	MA-3 lpr.	389,000	GE/Burroughs/ARMA	Radio-command; inertial	20	9,000	Two 165,000 lb. MA-3; one 57,000 lb. sustainer; E model operational.
.....	..	rj.	.....	.....	.....	.....	5,500	Clam and Slam are proposed chemical and nuclear low altitude missiles.
	1	Nuclear tj.	.....	.....	Command inertial	1+	5,500+	
.....	2	spr.	17.6	.....	Command	0.3	1.0	Wire-guided anti-tank missile. Lic. fr. Boelkow, KG, West Germany.
	1	lpr.	20,000	Gillfillan	Command	3	75	Nuclear and all-weather; deployed in Europe.
	1	spr.	.....	.....	Unguided	.....	15	Mobile tactal weapon. GE arming & fuzing.
r.	1	XM31E2	.....	.....	Unguided	.....	.....	Greater range and accuracy.
	1	530 lpr.	150,000	Ford Instrument	Inertial	.....	1,500	IRBM developed by Army, used by NATO.
	1	M-10E1 spr.	.....	Martin	Command	.....	20	Close tactical support; GE arming & fuzing.
	1	.....	.....	Hesse-Eastern	Unguided	.....	.....	Rocket grenade, anti-tank.
	1	XM261E1 spr.	.....	.....	Unguided	.....	.....	Close tactical support, GE arming & fuzing.
.....	1	.....	.....	.....	.....	2	15	Supply missile project; 50 lb. payload.
	1	J33-A-41 tj.	5,200	Goodyear AC	Atran/Inertial	0.9	1,200+	Improved matador; spr. booster.
	1	J33-A-37 tj.	3,700	GFE/Martin	MSQ radar/Shanicle	0.9	500+	Being replaced by Mace.
Hercules	3	spr.	260,000	NAA Autonetics	Inertial	20	5,500+	Silo & railroad car launch. Avco Mk. 5 nose cone.
	2	spr.	.....	Bendix	Inertial	.....	.....	Selective range artillery missile.
ules	2	spr.	.....	GE	Inertial	.....	.....	Inertial Guidance developed by MIT produced by Sperry/Autonetics.
	1	A-7 lpr.	78,000	Ford Instr.	Inertial	.....	200	Deployed in Europe.
	1	J79-3 tj.	10,000+	AC	Command or inertial	2+	1,000+	Now used as drone.
	1	spr.	.....	Sperry	Inertial	.....	85	Air transportable; will replace Corporal.
.....	1	.....	.....	.....	.....	.....	.....	Close-in support of troops.
	1	J57-P-17	15,000	Nortronics	Stellar inertial	0.9	5,500	Two spr. boosters.
	1	MB-3 lpr.	150,000	AC	Inertial	13	1,500	GE Mk. 2 heat sink nose cone.
	3	lpr.	330,000	AC/BTL/Rem. Rand/IBM	Radar-command, inertial	23	6,300	Avco Mk. 4 nose cone; range approx. 9,000 miles.
	3	lpr.	480,000	AC/MIT	Inertial	.....	9,000	Avco Mk. 6 nose cone; storable fuels.

IRBM — Intermediate Range Ballistic Missile
lpr — liquid propellant rocket
MIT — Mass. Institute of Technology
NOTS — Naval Ordnance Test Station
rj — ram jet
spr — solid propellant rocket
tj — turbojet
[1] — Gross takeoff weight

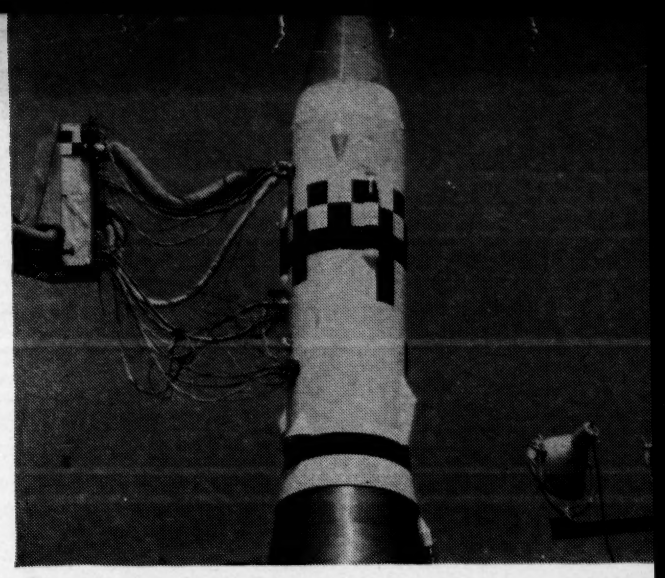
U.S.–U.S.S.R: Satellites and Space Probes

Name	Launch Date	Estimated Lifetime or End	Dimensions (in.) length x diam.	Weight lb.	Initial Altitude (miles)		Period (min.)	Inclination to Equator (degrees)
					Perigee	Apogee		
Vanguard II	Feb. 17, '59	200 years	20	21.5	347	2,046	125.3	32.9
Discoverer I	Feb. 28, '59	Mar. 5, '59	19.2 x 5	1,300	99	605	95.9	3 deg. off N-S axis
Pioneer IV	Mar. 3, '59	.....	20 x 9	13.4	91.7 million perihelion	107.9 million aphelion	406.9 days	.127 to ecliptic
Discoverer II	Apr. 13, '59	Apr. 26, '59	230.4 x 60 with 27 x 33 capsule	195 (capsule)	142	220	90.5	Polar
Explorer VI	Aug. 7, '59	1 year	29 x 26 (four solar paddles 18 x 18)	142	156	26,357	750	46.9
Discoverer V	Aug. 13, '59	.....	230.4 x 60 with 27 x 33 capsule	300 (capsule)	120	718	98.3	78.9
Discoverer VI	Aug. 19, '59	.....	230.4 x 60 with 27 x 33 capsule	300 (capsule)	139	537	95.3	84
Vanguard III	Sept. 18, '59	30–40 years	20 in. sphere with 26 in. tapered tube.	50	320	2,320	130	33.3
Explorer VII	Oct. 13, '59	20 years	30 x 30	91.5	344	673	101.2	50.3
Discoverer VII	Nov. 7, '59	.....	230.4 x 60 with 27 x 33 capsule	1700	104	550	95	82
Discoverer VIII	Nov. 20, '59	.....	230.4 x 60 with 27 x 33 capsule	300 (capsule)	120	1,000	103	81
Pioneer V	Mar. 11, '60	100,000 years	26 in. sphere with four solar vanes	94.8	74.9 million perihelion	92.3 million aphelion	311.6 days	3.35 to ecliptic
Tiros I	Apr. 1, '60	50–100 years	19 x 42	270	428.7	465.9	99.19	48.327
Transit I-B	Apr. 13, '60	16 months	36 in. sphere	265	233	479	96	51
Discoverer XI	Apr. 15, '60	Apr. 26, '60	230.4 x 60 with 27 x 33 capsule	300 (capsule)	109	380	92.25	80.1
Midas II	May 24, '60	40 months	264 x 60	5,000	292.1	322	94.3	33
Transit II-A (Navy Navigation Satellite)	June 22, '60	50 years	a) 36 in. sphere b) 20 in. sphere	a) 223 b) 42	a) 389 b) 382	a) 665 b) 657	a) 101.7 b) 101.6	a) 66.7 b) 66.8
Discoverer XIII	Aug. 10, '60	Aug. 11, '60	230.4 x 60 with 27 x 33 capsule	300 (capsule)	161	436	94.1	82.51
Echo I	Aug. 12, '60	Indefinite	26.5 in. sphere	132	945	1049	118.3	47.2
Discoverer XIV	Aug. 18, '60	Aug. 19, '60	230.4 x 60 with 27 x 33 capsule	300 (capsule)	116	502	94.5	79.6
Discoverer XV	Sept. 13, '60	Sept. 15, '60	230.4 x 60 with 27 x 33 capsule	300 (capsule)	130	472	94.24	80.93
Courier 1-B	Oct. 4, '60	2+ years	51 in. sphere	500	501	658	107	28.3
Explorer VIII	Nov. 3, '60	10+ years	30 x 30	90.14	258	1,423	[illegible]	49.9
Discoverer XVII	Nov. 12, '60	Nov. 14, '60	300 x 60 with 27 x 33 capsule	300	116	616	[illegible]6.45	81.8
Tiros II	Nov. 23, '60	50–100 years	19 x 42	280	387	453	98.2	48.5
Discoverer XVIII	Dec. 8, '60	Dec. 10, '60	300 x 60 with 27 x 33 capsule	300 (capsule)	154	459	94.1	80.9
Discoverer XIX	Dec. 20, '60	40 days	300 x 60	2100	128	323	92	83.4
Samos II	Jan. 31, '61	.....	312 x ...	11,000	300	350	95	.....

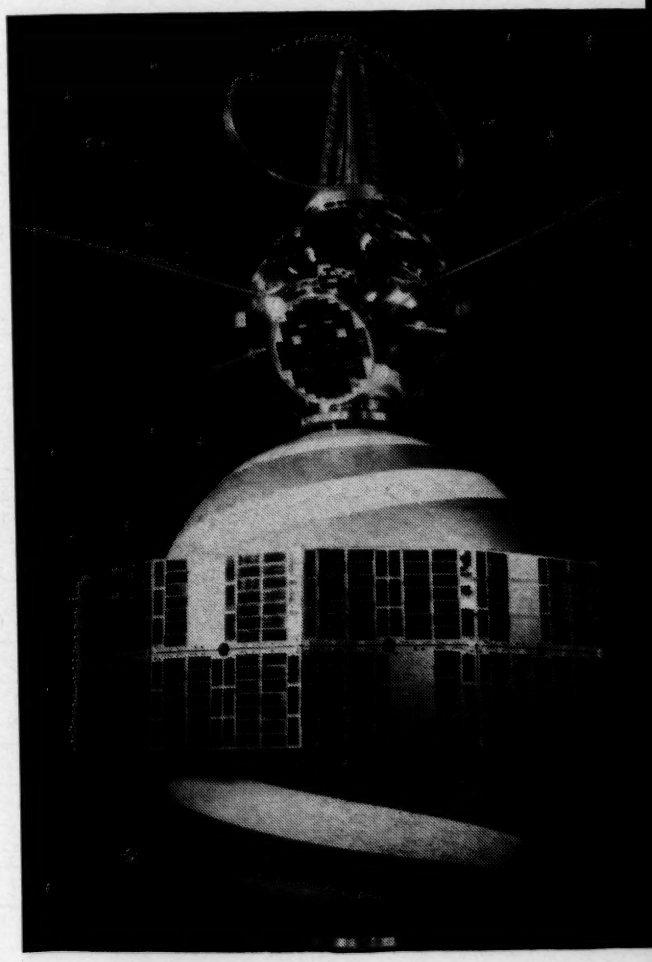
Lunik I (Mechta)	Jan. 2, '59	Indefinite	.....	800	91 million perihelion	120 million aphelion	443 days	1. to ecliptic
Lunik II	Sept. 12, '59	Sept. 13, '59	.....	858.4	.....	.....	.....	65
Lunik III	Oct. 4, '59	Apr. 20, '60	87 x 47	614	24,840	292,000	15 days	80
Sputnik IV (Spacecraft I)	May 14, '60	Indefinite	.....	10,008	188.5	228.7	[illegible]	64.9
Sputnik V (Spacecraft II)	Aug. 19, '60	Aug. 20, '60	.....	10,120	190	211	[illegible]	64.57
Sputnik VI (Spacecraft III)	Dec. 1, '60	Dec. 2, '60	.....	10,060	112	155	88.6	65
Sputnik VIII (Venus probe)	Feb. 12, '61 Feb. 12, '61	Indefinite Indefinite	....	14,000 1,418	125	196	89.7	64.9 ecliptic
Sputnik VII	Feb. 4, '61	Feb. 22, '61	.....	14,292	139	203.5	89.9	65

Period (min.)	Inclination to Equator (degrees)	Launching Vehicle	Remarks
125.3	32.9	Vanguard	Cloud cover study; satellite precession prevented interpretation of cloud cover data.
95.9	3 deg. off N-S axis	Thor-Agena	Satellite placed in near-polar orbit. Difficulty in stabilization caused tumbling which hampered comous tracking.
406.9 days	.127 to ecliptic	Juno II	Achieved Earth-Moon trajectory and yie ded important radiation data in space. Injection below ined velocity prevented near-lunar experiments.
90.5	Polar	Thor-Agena	Achieved near-circular polar orbit and controlled stabilization. Timer malfunction caused prture capsule ejection preventing recovery. Total weight in orbit 1600 lbs.
750	46.9	Thor-Able	Televised cloud-cover picture; detected ring of electrical current circling Earth; complete map of Vallen radiation belt obtained
98.3	78.9	Thor-Agena	Carrier re-entered Sept. 28, '59; capsule in polar orbit. Capsule ejected while satellite in improper ition for return. Total weight in orbit 1700 lbs.
95.3	84	Thor-Agena	Separation on A ug. 20, '59; no signal received and no recovery. Total weight in orbit 1700 lbs.
130	33.3	Vanguard	Survey of Earth's magnetic field over area covered; detailed location of lower edge of Van Allen belt; urate count of micrometeorite impacts. Total weight in orbit 100 lbs.
101.2	50.3	Juno II	Information on radiation and magnetic storms; controlled internal temperatures; detection of larscale weather patterns.
95	82	Thor-Agena	Electrical malfunction prevented stabilization in orbit and separation of 300 lb. data capsule. No rvery.
103	81	Thor-Agena	Orbit not in planned path; capsule ejected but not recovered. Total weight in orbit 1700 lbs.
311.6 days	3.35 to ecliptic	Thor-Able	Established communication 22.5 million miles from Earth; transmitted 138.9 hours of data re. so flare effects, particle energies and distribution and magnetic field phenomena in interplanetary space.
99.19	48.327	Thor-Able	Near circular orbit. Video system relayed cloud-cover photos. Photo data interrogation ceased June 17, '60.
96	51	Thor-Able-Star	Indicated a satellite navigation system for ships and aircraft is feasible.
92.25	80.1	Thor-Agena	Capsule ejected but not observed. No recovery. Total weight in orbit 1700 lbs.
94.3	33	Atlas-Agena	Test for the detection of missile launching with satellite-borne infrared sensors. Communicatio failed after two days.
) 101.7) 101.6	a) 66.7 b) 66.8	Thor-Able-Star	First time two satellites successfully launched at once, each orbiting and transmitting separately. emonstrated feasibility of all-weather global navigational satellites. GREB—Galactic Radiation Background.
94.1	82.51	Thor-Agena	Add'l telemetry added to determine reason for previous recovery failures. Capsule successfully ejeed and recovered.
118.3	47.2	Delta	Demonstrated feasibility of global communication using satellites. 100 ft. inflated aluminum sphere eflected radio waves up to frequencies of 20,000 mc.
94.5	79.6	Thor-Agena	Capsule successfully ejected and caught 8,000 ft. in mid-air by a C-119, 360 miles southwest of Hawaii.
94.24	80.93	Thor-Agena	Capsule ejected and landed in sea. Capsule sighted but recovery failed due to rough sea. Total veight in orbit 1700 lbs.
107	28.3	Thor-Able-Star	Simultaneously transmits, receives and stores approx. 68,000 coded words per minute. Operated for 18 days, relaying 118 million teletyped words, before apparent failure of decoder switching unit enced transmission.
	49.9	Juno II[1]	Measures positive ion and electron composition; gathers data on frequency, momentum and energy of micrometeorite impacts.
1 6.45	81.8	Thor-Agena	Explored radiation in lower Van Allen belts; carried micro-organisms, plant spore, artificially grown human cells. Recovered in mid-air. Total weight in orbit 2,100 lbs.
1 98.2	48.5	Delta[2]	Experimental television techniques and infrared equipment. Quality of wide-angle photos is poor.
94.1	80.9	Thor-Agena	Carried a variety of medical and technical experiments. Capsule recovered in mid-air after 48th orbit. Total weight in orbit 2,100 lbs.
92	83.4	Thor-Agena	Collected data on atmospheric phenomena and infrared radiation in support of Midas program.
95	.....	Atlas-Agena B	Carries high-resolution cameras. Anticipate a capsule ejection and recovery in future.

443 days	1. to ecliptic	.....	Measure temperature and pressure inside vehicle; study gas components of interplanetary matter and corpuscular radiation of Sun. Orbital weight 3,245 lbs.
.....	65	.....	Lunar impact. Confirmed lack of lunar atmosphere and lack of any lunar magnetic field above 60 gammas.
15 days	80	.....	Translunar satellite producing first photos of 70 per cent of moon's far side. Total orbital weight 4,037 lbs.
	64.9	.....	Pressure vessel separated from cabin but because of fault in orientation went into lopsided orbit instead of re-entering atmosphere.
	64.57	.....	Successful test of capsule and recovery system for development of manned space flight. Capsule reported to contain 2 dogs, rats, mice, flies, plants, fungi, water plants and seeds.
88.6	65	.....	Vehicle descended along uncalculated trajectory when signaled to return to Earth and was destroyed.
89.7	64.9 ecliptic	.....	Venus probe launched from orbiting Sputnik will reach Venus area in April, 1961, then go into a solar orbit
89.9	65	.....	Test of placing large satellite in precise orbit. Served as test for Sputnik VIII (Venus probe).



MIDAS II



TRANSIT III-B AND LOFTI

SPACE VEHICLES PRIOR TO 1959

Name	Launch Date	Est. Lifetime or End
Explorer I	Jan. 31, '58	3–5 years
Vanguard I	Mar. 17, '58	2,000 years
Explorer III	Mar. 26, '58	June 27, '58
Explorer IV	July 26, '58	1 year
Pioneer I	Oct. 11, '58	43 hr. 17.5 min.
Pioneer III	Dec. 6, '58	38 hr., 6 min.
Project Score	Dec. 18, '58	Jan. 21, '59
Sputnik I	Oct. 4, '57	Jan. 4, '58
Sputnik II	Nov. 3, '57	Apr. 13, '58
Sputnik III	May 15, '58	Mar., '59

U.S. Spae Vehicles and Rockets

CATEGORY	Vehicle Name	GENERAL		AIRFRAME				POWERPLANT		
		User	Prime Contractor	Manufacturer	Overall length, ft.	Body diameter, ft.	Launching wt.	Manufacturer	No. of engines	Engine Designation
Satellite Vehicles	Atlas Able	UF/NASA	STL	Convair	99.4	10	255,000	N.A.A. Rocketdyne Aerojet-General Allegany Ballistic Lab. STL	3 1 1 1	MA-2 lpr AJ-10-101 lpr ABL-248 spr spr
	Atlas Agena	UF/NASA	Lockheed Aircraft	Convair/Lockheed	98.2	10	265,000	N.A.A. Rocketdyne Bell Aerosystems	3 1	MA-2 lpr epr
	Atlas Centaur	NA	Convair	Convair	107.8	10	291,000	N.A.A. Rocketdyne P&W	3 2	MA-2 lpr lpr
	Delta	NA	Douglas	Douglas	92	8	114,000	N.A.A. Rocketdyne Aerojet-General Allegany Ballistic Lab.	1 1 1	MB3-I AJ10-118 ABL-248 spr
	Juno I	NA	ABMA/Chrysler	Chrysler	.....	.....	64,000	Chrysler JPL	1 15	A-7 lpr spr
	Juno II	NA	ABMA/Chrysler	Chrysler	76.5	8.8	121,000	N.A.A. Rocketdyne JPL	1 15	S3D lpr spr
	Nova	NA	.....	.....	250	35	5 million	N.A.A. Rocketdyne	var	F-1 lpr
	Saturn	NA	NASA	NASA	185	21.6	1,160,000	N.A.A. Rocketdyne	8	H-1 lpr
	Scout	NA	Chance Vought	Chance Vought	70.97	3.35	36,718	Aerojet-General Thiokol ABL ABL	1 1 1 1	spr XM-33 X-254 X-248
	Blue Scout	USF	Aeronutronic	Chance Vought	.....	.....	.....	.....	..	.....
	Thor-Able	USF/NASA	Space Technology	Douglas	88.1	8	105,000	N.A.A. Rocketdyne Aerojet-General Allegany Ballistic Lab. Thiokol	1 1 1 1	MB-3 lpr AJ10-42 lpr ABL-248 spr spr
	Thor-Agena	USF/NASA	Lockheed Aircraft	Douglas/Lockheed	79	8	108,500	N.A.A. Rocketdyne Bell Aerosystems	1 1	MB-3 lpr lpr
Sounding Rockets	Aerobee	Army/Navy/USAF	Aerojet-General	Aerojet-General	24.8	1.3	1,900	Aerojet-General	1	lpr
	Aerobee 150	Navy/USAF	Aerojet-General	Aerojet-General	31.2	1.25	1,900	Aerojet-General	1	lpr
	Aerobee 300	USAF	Aerojet-General	Aerojet-General	32.5	1.25	2,200	Aerojet-General		lpr & spr.
	Arcas	Navy	Atlantic Research	Atlantic Research	6.5	4.5	77	Atlantic Research		29KS 366
	Arcas Robin	USAF	Atlantic Research	Atlantic Research	6	4.5	73	Atlantic Research		29KS 366
	Arcon	NASA	Atlantic Research	Atlantic Research	13.3	0.5	230	Atlantic Research	1	33KS 945
	Argo E-5	NASA	Aerolab Development Co.	Aerolab Development Co.	61.6	2.58	13,000	Radford Hercules/Thiokol	5	spr
	Ascamp	.....	Marquardt [Cooper]	Marquardt [Cooper]	18.3	0.54	286.5	Marquardt [Cooper]/JPL	2	spr
	Asp I	Navy	Marquardt [Cooper]	Marquardt [Cooper]	12	0.5	216.5	Marquardt [Cooper]	1	spr
	Aspan 150	USAF	Marquardt [Cooper]	Marquardt [Cooper]	26.4	1.4	1,503	.....	2	spr
	Boa	USAF	Marquardt [Cooper]	Marquardt [Cooper]	39	1.9	6,666	.....	3	spr
	Cajun	USAF	U. of Michigan	.....	13.3	0.5	254	Thiokol	1	spr
	Deacon	NASA	ABL/Hercules	ABL	9.2	0.5	153	ABL/Hercules	1	spr
	Iris	NASA	Atlantic Research	Atlantic Research	19	1	1,229	Atlantic Research	1	51.6KS 3850
	Nike Nike	USAF	Marquardt [Cooper]	Marquardt [Cooper]	22.2	1.3	5,566	Radford/Hercules/Thiokol	2	spr
	Rockair	Navy	.....	.....	4	.2	18	Sunflower/Hercules	1	spr
	Rockaire	USAF	Douglas	.....	8.9	.8	181	.....	1	DM-16 JATO
	Roksonde 100	.....	Marquardt [Cooper]	Marquardt [Cooper]	5.3	.4	17.9	Marquardt [Cooper]	1	spr
Test Vehicles	Automet	Army	ARGMA	GE	.....	.....	.....	.....		.....
	Katybird KDB-1	Navy/Army	Beech	Beech	15	1.5	593	McCulloch	1	O150-4A
	Katybird XKD2B-1	Navy/USAF	Beech	Beech	12.8	1.1	560	Rocketdyne	1	XLR-64-NA2
	Mercury-Redstone	NASA	NASA	Chrysler	83	5.9	66,000	Rocketdyne	1	A-7 lpr
	Roadrunner-NA273	Army	N.A.A. Columbus	N.A.A. Columbus	19	1	957	Marquardt [Cooper]/ Rocketdyne	1 1	MA74ZAA 5.7-NS-5500
	Skokie I	USAF	Cook Electric	.....	25	1.7	2,400	.....	3	spr

POWERPLANT				REMARKS
		Engine Designation	Rated thrust, lb.	
yne ic Lab.		MA-2 lpr AJ-10-101 lpr ABL-248 spr spr	360,000 7,500 2,500 400	Lunar orbiter and planetary probe rocket. Also known as Able IV Atlas. Unsuccessful in three launch attempts. No further use planned.
	3 1	MA-2 lpr epr	360,000 16,000	Designed to orbit heavy payloads or send impacting or orbiting probes to moon and planets.
	3 2	MA-2 lpr lpr	360,000	High energy general-purpose space vehicle; 2nd stage engines burn hydrogen in oxygen. First test flights in mid-1961.
Lab.	1 1 1	MB3-I AJ10-118 ABL-248 spr	150,000 7,500 2,500	Descendent of Thor-Ables and similar to Atlas Able IV. Vehicle for weather, ionosphere, radiation belt, orbiting optical and radio astronomical observatory satellites. To phase out in 1962.
	1 15	A-7 lpr spr	83,000 1,000	Vehicle for Explorer satellites, widely mis-named Jupiter-C. 1st stage extended Redstone; 2nd stage 11 Sergeants, scaled-down; 3rd stage 3 Sergeants, scaled-down; 4th stage 1 Sergeant scaled-down.
	1 15	S3D lpr spr	150,000 1,000	Launcher of space probes and Pioneer IV. 1st stage extended Jupiter IRBM; upper stages consist of scaled-down Sergeants in same configuration as Juno I. To phase out in 1961.
	var	F-1 lpr	varies	Stages and thrust will vary with mission. Concept only.
	8	H-1 lpr	1,500,000	Basic configuration clusters eight engines with future generations adding add'l. stages. First test of booster stage (Hi-Cluster) in 1961.
	1 1 1 1	spr XM-33 X-254 X-248	105,000 55,000 15,000 3,100	Dual purpose sounding rocket and economy satellite vehicle. Basic mission is to place 200 lb. payload in a 300-mile orbit. Has a variety of configurations.
.....	..	.....	.....	Configuration and air frame vary. Also called HETS and will be used for aerodynamic tests of Dyna-Soar.
ab.	1 1 1 1	MB-3 lpr AJ10-42 lpr ABL-248 spr spr	150,000 7,500 2,500	Also known as Able I. 2nd stage is Vanguard 2nd stage; 4th stage is Falcon motor used as a retrorocket. Thor-Delta has guidance in 2nd stage. Rocketdyne MB-3-11 engine with 165,000 lb. t. will be used for space vehicles.
	1 1	MB-3 lpr lpr	150,000 15,000	Vehicle configuration for moderately heavy satellites in low earth orbits, but unsuitable for light payloads requiring high velocity.
	1	lpr	4,000	Tower launched. Uses an Aerojet 2.5KS-18,000 booster and Nike-type gas regulator valve.
	1	lpr	4,100	Aerobee-Hi; has 3 fins. Corrosive acid propellant makes immediate launch necessary. Aerobee 150-A has 4 fins without corrosive acid problem.
		lpr & spr.	4,100+	Similar to Aerobee 150 or 150-A but has the Douglas Sparrow as an add'l stage.
		29KS 366	350	Carried 5-20 lb. payload to 66 mile altitude. Vehicle under development will extend altitude to 84 miles.
		29KS 366	350	8 lb. payload to 40 mile altitude.
	1	33KS 945	945	40 lb. payload to 61 mile altitude. Tower launched spr. NASA is improving reliability of engine.
/Thiokol	5	spr	.....	A number of variations. Ltr. "D" indicates 4 stages, "E" means 5 etc.
r]/JPL	2	spr	.....	Capable of lifting payloads to 150 miles. Asp I is 1st stage and a scaled-down Sergeant is 2nd stage.
r]	1	spr	5,850	Carried 20-85 lb. payload to 130,000-250,000 ft. Asp IV carried payload 300,000-500,000 ft.
.....	2	spr	.....	Nike 1st stage, Asp I 2nd stage. Also known as Nike-Asp.
.....	3	spr	.....	Honest John 1st stage; Nike 2nd & 3rd stage. Carry 500 lb. payload 75 miles high.
	1	spr	8,300	Nike Cajun offered by Marquardt [Cooper] uses JATO M-5 Nike as 1st stage.
	1	spr	.....	
	1	51.6KS 3850	4,510	100-lb. payload to 190 mile altitude.
/Thiokol	2	spr	.....	2-stage rocket using Nike JATO M-5 as 1st stage. Similar to Nike Cajun. Also called Python.
	1	spr	.....	2.75 in. FFAR rocket instrumented for sounding experiments.
.....	1	DM-16 JATO	7,800	Air-launched sounding rocket; 40 lb. payload.
		spr	.....	Designed to carry payload up to 125,000 ft.
		.....	.....	Test application to future operational missile weapon system.
	1	O150-4A	120	Missile target.
	1	XLR-64-NA2	635	Missile target; USAF designation Q-12.
	1	A-7 lpr	78,000	NASA has purchased 8 for sub-orbital training of Project Mercury pilots.
]/	1 1	MA74ZAA 5.7-NS-5500	 5,500	Designed to fly missions from 300 to 60,000 ft. and from subsonic to Mach 2.
.....	3	spr	33,000	Air launched parachute test vehicle; Skokie II is Mach 2 version.

U. S. Military Aircraft

Manufacturer	Military designation	Military name	Primary mission	Number in crew	Over-all span	Over-all length	Over-all height, 3 pt.	Gross wing area, sq. ft.	Weight empty, lb.	Normal gross wt., lb.	Maximum gross wt., lb.	Number, make, model and max. rating, ea.
	BASIC AIRCRAFT DATA			DIMENSIONS					WEIGHTS			POWERPLANT
Beech Aircraft Corp.	T-34A	Mentor	Trainer	2	32.8′	25.9′	10′	177.6	2,156	2,950	2,950	1 Con. O-470-13 @ 225 hp.
Wichita, Kansas	T-34B	Mentor	Trainer	2	32.8′	29.9′	10′	177.6	2,254	2,985	2,984	1 Con. O-470-13 @ 225 hp.
	L-23D	Seminole	Liaison Transport	1–2	45.25′	31.5′	11.6′	277	4,460	7,000	7,000	2 Lyc. GSO-480-B1B6 @ 340 hp.
	RL-23D	.....	Radar Recon.	2	50.3′	31.11′	11.6′	293.9	5,954	7,350	7,350	2 Lyc. GSO-480-B1B6 @ 340 hp.
	L-23F	.....	Liaison Transport	1–2	45.8′	33.3′	14.1′	277	4,740	7,700	7,700	2 Lyc. IGSO-480-A1A6 @ 340 hp.
Boeing Airplane Co.	B-47E	Stratojet	Med. Bomber	3	116′	107′	28′	.....	....	.....	200,000	6 GE J47-GE-25 @ 6,000 lb.t.
Seattle, Wash.	B-52A, B	Stratofortress	Hvy. Bomber	6	185′	152′ 9″	48′ 3″	4,000	....	350,000+	.....	8 P&W J57-P-1W @ 10,000 lb.t.
	B-52C,D,E	Stratofortress	Hvy. Bomber	6	185′	152′ 9″	48′ 3″	4,000	....	400,000+	.....	8 P&W J57-P-19W @ 10,000 lb.t.
	B-52F	Stratofortress	Hvy. Bomber	6	185′	152′ 9″	48′ 3″	4,000	....	400,000+	.....	8 P&W J57-P-43W @ 10,000 lb.t.
	B-52G	Stratofortress	Hvy. Bomber	6	185′	157′ 6″	40′ 9″	4,000	....	488,000	.....	8 P&W J57-P-43W @ 10,000 lb.t.
	B-52H	Stratofortress	Hvy. Bomber	6	185′	157′ 6″	40′ 9″	4,000	....	488,000	.....	8 P&W TF-33-P-3 @ 17,000 lb.t.
	.....	Dyna-Soar	Researeh Vehicle	..	.....	.....	.....	.....	....	.....	.....	.....
Cessna Aircraft Co.	T-37B	.....	Trainer	2	33′ 10″	29′ 3″	9′ 2″	183.9	4,056	6,569	6,600	2 Con. J-69-T-25 @ 1,025 lb.t.
Wichita, Kansas	407	.....	.....	..	36′ 3″	31′ 8″	9′ 4″	200.32	4,658	9,300	9,500	2 Con. 356-9A @ 1,400 lb.t.
	U-3B	.....	Administrative	5	35′ 9″	29′ 7″	9′ 11″	175	3,330	4,990	4,990	2 Con. IO-470-D @ 260 hp.
Chance Vought Corp.	F8U-1	Crusader I	Day Fighter	1	35′ 8″	54′ 3″	15′ 9″	.....	....	.....	.....	1 P&W J57-P-4A @ 10,000+ lb.t.
Dallas, Texas	F8U-1P	Crusader I	Photo-Recon.	1	35′ 8″	54′ 6″	15′ 9″	.....	....	.....	.....	1 P&W J57-P-4A @ 10,000+ lb.t.
	F8U-2	Crusader II	Day Fighter	1	35′ 8″	54′ 3″	15′ 9″	.....	....	.....	.....	1 P&W J57-P-16 @ 18,000 lb.t.
	F8U-2N	Crusader II	AW Fighter	1	35′ 8″	54′ 3″	15′ 9″	.....	....	.....	.....	1 P&W J57-P-20 @ 18,000 lb.t.
Convair Division	F-102A	Delta Dagger	AW Interceptor	1	38′ 1″	68′ 3″	21′ 2″	.....	....	.....	.....	1 P&W J57-P-23 @ 10,000+ lb.t.
General Dynamics Corp.	TF-102A	.....	Trainer	2	38′ 1″	59′ 2″	20′ 7″	.....	....	.....	.....	1 P&W J57-P-23 @ 10,000+ lb.t.
San Diego, Calif.	F-106A	Delta Dart	AW Interceptor	1	38′ 3″	70′ 9″	20′ 3″	.....	....	.....	.....	1 P&W J75 @ 17,500+ lb.t.
	T-29C	Flying Classroom	Crew Trainer	4	91′ 9″	74′ 8″	27′ 3″	817	29,000	43,575	43,575	2 P&W R2800-99W @ 2,500 hp.
Ft. Worth, Tex. Division	B-58	Hustler	Bomber	3	56′ 10″	96′ 9″	31′ 6″	1,542	....	160,000	.....	4 GE J79 @ 15,000 lb.t.
	NX-2	.....	Bomber	..	.....	.....	.....	.....	....	.....	.....	Nuclear Power
Douglas Aircraft Co.	A3D-2	Skywarrier	Attack	3	72′ 6″	76′ 4″	22′ 9″	780	38,298	70,000	.....	2 P&W J57-P-10 @ 10,500 lb.t.
Santa Monica, Calif.	A4D-2N	Skyhawk	AW Attack	1	15′	40′ 1″	15′ 2″	260	9,559	16,236	.....	1 Wr. J65-W-16A @ 7,700 lb.t.
	A4D-5	Skyhawk	Attack	1	15′	40′ 1″	15′ 2″	260	9,559	.....	.....	1 P&W J52 @ 8,500 lb.t.
	F6D	Missileer	Interceptor	2	.....	.....	.....	.....	....	.....	.....	2 P&W TF30-P-2 @ 10,000 lb.t.
Goodyear Aircraft Corp.	ZS2G-1	.....	ASW Airship	8	67′ 6″	285′ 3″	92′ 6″	1,959	30,764	47,600	.....	2 Wr. R1300-4 800 hp. @ 2600 rpm
Akron, Ohio	ZPG-2	.....	ASW Airship	14	75′ 5″	342′ 7″	96′ 8″	2,080	46,732	66,800	.....	2 Wr. R1300-2A 800 hp. @ 2600 rpm
	ZP6-2W	.....	AEW Airship	24	75′ 5″	342′ 7″	106′ 9″	2,080	47,779	66,800	.....	2 Wr. R1300-2A 800 hp. @ 2800 rpm
	ZP6-3W	.....	AEW Airship	21	85′ 2″	403′ 5″	117′ 8″	2,612	71,793	93,496	100,000	2 Wr. R1820-88 1525 bhp. @ 2800 rpm
	GA-468	Inflatoplane	Recon., Rescue	1	22′	19′ 8″	7′	110	225	.....	550	Nelson 40 bhp. @ 3800 rpm
	GA-466	Inflatoplane	Recon., Rescue	2	28′	19′ 3″	7′ 10″	154	290	.....	740	McCulloch
Grumman Aircraft Eng'rg Corp.	F9F-8T	Cougar	Trainer	2	34′ 6″	48′ 6″	12′ 1″	.....	....	20,600	.....	1 P&W J48-P-8A @ 7,200 lb.t.
Bethpage, N. Y.	F11F-1	Tiger	Interceptor	1	31′ 8″	40′ 10″	12′ 9″	250	13,428	21,174	24,078	1 Wr. J65-W-18 @ 10,500 lb.t.
	F11F-1F	Super Tiger	Interceptor	1	31′ 8″	40′ 10″	12′ 9″	250	....	.....	.....	1 GE J79-3A @ 14,800 lb.t.
	S2F-1	Tracker	ASW	4	69′ 8″	42′ 3″	16′ 3″	.....	....	.....	.....	2 Wr. R1820-82 @ 1525 hp.
	S2F-3	Tracker	ASW	4	72′ 7″	43′ 6″	16′ 7″	.....	....	.....	.....	2 Wr. R1820-82 @ 1525
	WF-2	Tracer	AEW	4	69′ 8″	45′ 4″	16′ 10″	507	....	.....	.....	2 Wr. R1820 @ 1525 hp.
	W2F-1	Hawkeye	AEW	5	80′ 7″	56′ 4″	16′	.....	....	.....	49,500	2 All. T56-A8 @ 4,050 eshp.
	AO-1AF	Mohawk	Observation	2	42′	41′	12′ 8″	330	9,295	11,672	14,679	2 Lyc. T53-L-3 @ 1,005 eshp.
	A2F-1	.....	Attack	2	.....	.....	.....	.....	....	.....	.....	2 P&W J52 @ 7,500 lb.t.
Lockheed Aircraft Corp.	F-104G	Super Starfighter	Interceptor	1	21′ 11″	54′ 9″	13′ 6″	.....	....	.....	.....	1 GE J79-3A @ 14,800 lb.t.
Burbank, Calif.	F-104F	Super Starfighter	Fighter Bomber	2	21′ 11″	54′ 9″	13′ 6″	.....	....	.....	.....	1 GE J79-3A @ 14,800 lb.t.
	F-104C	Starfighter	Fighter	1	21′ 11″	54′ 9″	13′ 6″	.....	....	.....	.....	1 GE J79-7 @ 15,800 lb.t.
	F-104D	Starfighter	Tac. Trainer	2	21′ 11″	54′ 9″	13′ 6″	.....	....	.....	.....	1 GE J79-7 @ 15,800 lb.t.
	EC-121D	Warning Star	Radar Picket	31	123′ 5″	116′ 2″	27′	1,654	.....	.....	.....	4 Wr. R3350-91 @ 3,250 hp.
	P2V-7	Neptune	ASW	..	101′ 4″	91′ 8″	29′ 4″	1,000	46,358	76,338	.....	2 Wr. R3350-32W @ 3,250 hp, also 2 We. J34 @ 3,400 lb.t.
	P3V-1	.....	ASW	10	99′	104′ 7″	33′ 1″	1,300	....	125,000	.....	4 All. T56-A-10W @ 4,500 eshp.
	U-2	.....	Research	1	.....	.....	.....	.....	....	.....	.....	1 P&W J57 @ 18,000 lb.t.
McDonnell Aircraft Corp.	F-101B	Voodoo	Interceptor	2	40′	.....	18′	.....	....	.....	.....	2 P&W J57-P-55 @ 10,000+ lb.t.
St. Louis Mo.	F4H-1	Phantom II	AW Interceptor	2	38′ 5″	56′	.....	.....	....	.....	.....	2 GE J79-2 @ 16,250
North American Aviation, Inc.	B-70	Valkyrie	Bomber	4	.....	.....	.....	.....	....	.....	600,000	6 GE J93 @ 25,000+ lb.t.
Los Angeles, Calif.	F-86F	Sabre	Fighter-Bomber	1	37′ 1″	37′ 5″	14′ 7″	.....	....	.....	17,000	1 GE J47-27 @ 5,970 lb.t.
	F-86H	Sabre	Fighter-Bomber	1	37′ 1″	38′ 8″	15′	.....	....	.....	.....	1 GE J73-3 @ 8,920 lb.t.
	F-86K	Sabre	Interceptor	1	37′ 1″	42′ 4″	15′	.....	....	18,500	20,347	1 GE J47-33 @ 7,650 lb.t.
	F-86L	Sabre	Interceptor	1	37′ 1″	42′ 4″	15′	.....	....	.....	.....	1GE J47-33 @ 7,650 lb.t.
	F-100C	Super Sabre	Fighter	1	38′	47′	15′	.....	....	.....	.....	1 P&W J57-P-7 @ 10,000 lb.t.
	F-100D	Super Sabre	Fighter-Bomber	1	38′	47′	16′	.....	....	.....	.....	1 P&W J57-P-21 @ 10,000+ lb.t.
	F-100F	Super Sabre	Fighter-Bomber	2	39′	50′	16′	385.2	21,346	34,235	.....	1 P&W J57 @ 10,000+ lb.t.
	F-107A	.....	Research	1	36′ 7″	60′ 10″	19′ 8″	.....	....	.....	.....	1 P&W J75 @ 17,500 lb.t.
	X-15	.....	Research	1	22′	50′	13′	200	....	.....	31,275	1 XLR-99RM-I @ 57,000 lb.t.
	T-39	Saberliner	Utility	2	44′ 5″	43′ 8″	15′ 11″	342.5	9,199	15,330	.....	2 P&W J60 @ 3,000 lb.t.
Columbus (Ohio) Division	FJ-4B	Fury	Fighter-Bomber	1	39′ 1″	36′ 6″	13′ 11″	338	....	19,900	.....	1 Wr. J65-W-16A @ 7,700 lb.t.
	A3J-1	Vigilante	AW Attack	2	53′	73′	20′	.....	....	.....	.....	2 GE J79-2 @ 15,000 lb.t.
	T2J-1	Buckeye	Trainer	2	36′	38′ 8″	14′ 9″	255	6,893	9,916	11,373	1 We. J34-46 @ 3,400 lb.t.
Northrop Corp.	T-38A	Talon	Trainer	2	25′ 3″	44′ 3″	12′ 10″	.....	7,200	.....	11,500	2 GE J85-5 @ 3,850 lb.t.
Hawthorne, Calif.	N-156F	Freedom Fighter	Fighter	1	26′ 5″	44′ 10″	13′ 2″	173.44	7,596	12,190	16,230	2 GE J85-5 @ 3,850 lb.t.
	F-89J	Scorpion	AW Interceptor	2	56′	53′	17′	.....	....	.....	40,000	2 All. J35-A-35 @ 15,000 lbs. w. aft. bur.
Republic Aviation Corp.	F-105D	Thunderchief	AW Fight.-Bomb.	1	34′ 11″	64′ 3″	19′ 8″	385	28,000	34,000	46,000	1 P&W J75-P19W @ 26,000+ lb.t.
Farmingdale, N. Y.	F-105B	Thunderchief	Fighter-Bomber	1	34′ 11″	63′ 11″	19′ 8″	385	....	.....	.....	1 P&W J75-P5 @ 20,000+ lb.t.
Temco Electronics & Missiles Co.	TT-1	Pinto	Trainer	2	29′ 10″	30′	10′ 10″	150	3,139	4,400	4,400	1 Con. J69-T-2 @ 920 lb.t.

U. S. Military Aircraft

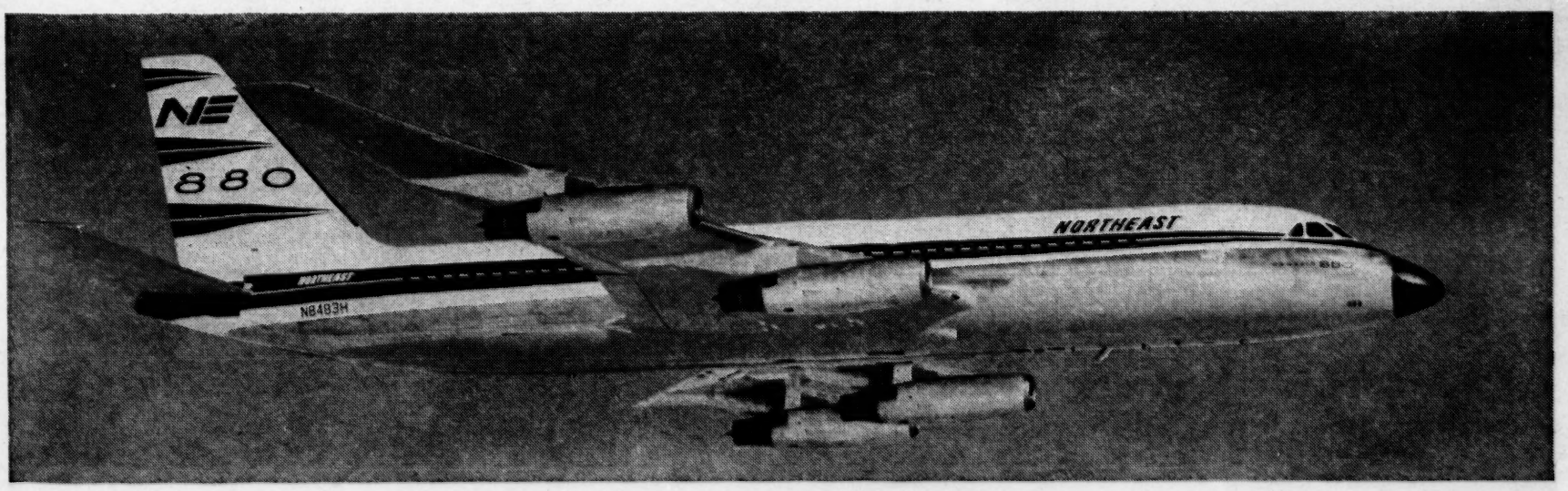
Manufacturer	Military designation	Military name	Primary mission	Number in crew	Over-all span	Over-all length	Over-all height, 3 pt.	Gross wing area, sq. ft.	Weight empty, lb.	Normal gross wt., lb.	Maximum gross wt., lb.	Number, make, model and max. rating, ea.	Normal fuel cap., gal.	Maximum speed, mph.	Initial rate of climb, fpm.	Stall speed, dirty, mph.	Service ceiling, ft.	Combat radius, mi.	
	BASIC AIRCRAFT DATA			DIMENSIONS					WEIGHTS			POWERPLANT	PERFORMANCE						
Beech Aircraft Corp. *Wichita, Kansas*	T-34A	Mentor	Trainer	2	32.8′	25.9′	10′	177.6	2,156	2,950	2,950	1 Con. O-470-13 @ 225 hp.	50	189	1,120	56	18,200	.....	2 x 30 ca
	T-34B	Mentor	Trainer	2	32.8′	29.9′	10′	177.6	2,254	2,985	2,984	1 Con. O-470-13 @ 225 hp.	50	188	1,100	58	18,100	.....	2 x 30 ca
	L-23D	Seminole	Liaison Transport	1–2	45.25′	31.5′	11.6′	277	4,460	7,000	7,000	2 Lyc. GSO-480-B1B6 @ 340 hp.	230	230	1,580	84	25,500	.....	None
	RL-23D	.....	Radar Recon.	2	50.3′	31.11′	11.6′	293.9	5,954	7,350	7,350	2 Lyc. GSO-480-B1B6 @ 340 hp.	168	230	1,463	84	23,800	.....	None
	L-23F	.....	Liaison Transport	1–2	45.8′	33.3′	14.1′	277	4,740	7,700	7,700	2 Lyc. IGSO-480-A1A6 @ 340 hp.	230	239	1,300	80	27,000	.....	None
Boeing Airplane Co. *Seattle, Wash.*	B-47E	Stratojet	Med. Bomber	3	116′	107′	28′	.....	....	.....	200,000	6 GE J47-GE-25 @ 6,000 lb.t.	....	600+	.....	...	40,000+	1,500+	2 x 20 m
	B-52A, B	Stratofortress	Hvy. Bomber	6	185′	152′ 9″	48′ 3″	4,000	....	350,000+	.....	8 P&W J57-P-1W @ 10,000 lb.t.	....	600+	.....	...	50,000+	.....	.....
	B-52C,D,E	Stratofortress	Hvy. Bomber	6	185′	152′ 9″	48′ 3″	4,000	....	400,000+	.....	8 P&W J57-P-19W @ 10,000 lb.t.	....	600+	.....	...	50,000+	.....	.....
	B-52F	Stratofortress	Hvy. Bomber	6	185′	152′ 9″	48′ 3″	4,000	....	400,000+	.....	8 P&W J57-P-43W @ 10,000 lb.t.	....	600+	.....	...	50,000+	.....	.....
	B-52G	Stratofortress	Hvy. Bomber	6	185′	157′ 6″	40′ 9″	4,000	....	488,000	.....	8 P&W J57-P-43W @ 10,000 lb.t.	....	600+	.....	...	50,000+	.....	2 NAA
	B-52H	Stratofortress	Hvy. Bomber	6	185′	157′ 6″	40′ 9″	4,000	....	488,000	.....	8 P&W TF-33-P-3 @ 17,000 lb.t.	....	.....	.....	...	.....	.....	.....
	.....	Dyna-Soar	Researeh Vehicle	..	.....	.....	.....	.....	....	.....	.....	.....	....	.....	.....	...	.....	.....	.....
Cessna Aircraft Co. *Wichita, Kansas*	T-37B	.....	Trainer	2	33′ 10″	29′ 3″	9′ 2″	183.9	4,056	6,569	6,600	2 Con. J-69-T-25 @ 1,025 lb.t.	321	408	3,200	85	39,200	398	None
	407	.....	.....	..	36′ 3″	31′ 8″	9′ 4″	200.32	4,658	9,300	9,500	2 Con. 356-9A @ 1,400 lb.t.	550	485	3,650	87	46,000	708	.....
	U-3B	.....	Administrative	5	35′ 9″	29′ 7″	9′ 11″	175	3,330	4,990	4,990	2 Con. IO-470-D @ 260 hp.	133	233	1,680	75	20,000	.....	None
Chance Vought Corp. *Dallas, Texas*	F8U-1	Crusader I	Day Fighter	1	35′ 8″	54′ 3″	15′ 9″	.....	....	.....	.....	1 P&W J57-P-4A @ 10,000+ lb.t.	....	1,100	.....	...	50,000+	.....	4 x 20 m
	F8U-1P	Crusader I	Photo-Recon.	1	35′ 8″	54′ 6″	15′ 9″	.....	....	.....	.....	1 P&W J57-P-4A @ 10,000+ lb.t.	....	1,100	.....	...	50,000+	.....	.....
	F8U-2	Crusader II	Day Fighter	1	35′ 8″	54′ 3″	15′ 9″	.....	....	.....	.....	1 P&W J57-P-16 @ 18,000 lb.t.	....	M<2	.....	...	50,000+	.....	4 x 20 m
	F8U-2N	Crusader II	AW Fighter	1	35′ 8″	54′ 3″	15′ 9″	.....	....	.....	.....	1 P&W J57-P-20 @ 18,000 lb.t.	....	M<2	.....	...	50,000+	.....	4 x 20 m
Convair Division General Dynamics Corp. *San Diego, Calif.*	F-102A	Delta Dagger	AW Interceptor	1	38′ 1″	68′ 3″	21′ 2″	.....	....	.....	.....	1 P&W J57-P-23 @ 10,000+ lb.t.	....	M1+	.....	...	50,000+	.....	GAR-9
	TF-102A	.....	Trainer	2	38′ 1″	59′ 2″	20′ 7″	.....	....	.....	.....	1 P&W J57-P-23 @ 10,000+ lb.t.	....	M1+	.....	...	50,000+	.....	.....
	F-106A	Delta Dart	AW Interceptor	1	38′ 3″	70′ 9″	20′ 3″	.....	.....	.....	.....	1 P&W J75 @ 17,500+ lb.t.	....	M2+	.....	...	60,000+	500	MB-1 C
Ft. Worth, Tex. Division	T-29C	Flying Classroom	Crew Trainer	4	91′ 9″	74′ 8″	27′ 3″	817	29,000	43,575	43,575	2 P&W R2800-99W @ 2,500 hp.	1,550	300	1,370	92	24,000	.....	None
	B-58	Hustler	Bomber	3	56′ 10″	96′ 9″	31′ 6″	1,542	....	160,000	.....	4 GE J79 @ 15,000 lb.t.	15,000	M2+	.....	...	65,000+	.....	Varied
	NX-2	.....	Bomber	..	.....	.....	.....	.....	.....	.....	.....	Nuclear Power	....	.....	.....	...	.....	.....	.....
Douglas Aircraft Co. *Santa Monica, Calif.*	A3D-2	Skywarrier	Attack	3	72′ 6″	76′ 4″	22′ 9″	780	38,298	70,000	.....	2 P&W J57-P-10 @ 10,500 lb.t.	4,385	600+	.....	...	.....	.....	2 x 20
	A4D-2N	Skyhawk	AW Attack	1	15′	40′ 1″	15′ 2″	260	9,559	16,236	.....	1 Wr. J65-W-16A @ 7,700 lb.t.	800	650+	.....	...	.....	.....	2 x 20
	A4D-5	Skyhawk	Attack	1	15′	40′ 1″	15′ 2″	260	9,559	.....	.....	1 P&W J52 @ 8,500 lb.t.	....	.....	.....	...	.....	.....	.....
	F6D	Missileer	Interceptor	2	.....	.....	.....	.....	.....	.....	.....	2 P&W TF30-P-2 @ 10,000 lb.t.	....	.....	.....	...	.....	.....	6 AAM
Goodyear Aircraft Corp. *Akron, Ohio*	ZS2G-1	.....	ASW Airship	8	67′ 6″	285′ 3″	92′ 6″	1,959	30,764	47,600	.....	2 Wr. R1300-4 800 hp. @ 2600 rpm	....	.....	.....	...	.....	.....	.....
	ZPG-2	.....	ASW Airship	14	75′ 5″	342′ 7″	96′ 8″	2,080	46,732	66,800	.....	2 Wr. R1300-2A 800 hp. @ 2600 rpm	....	.....	.....	...	.....	.....	.....
	ZP6-2W	.....	AEW Airship	24	75′ 5″	342′ 7″	106′ 9″	2,080	47,779	66,800	.....	2 Wr. R1300-2A 800 hp. @ 2800 rpm	....	.....	.....	...	.....	.....	.....
	ZP6-3W	.....	AEW Airship	21	85′ 2″	403′ 5″	117′ 8″	2,612	71,793	93,496	100,000	2 Wr. R1820-88 1525 bhp. @ 2800 rpm	282	.....	.....	...	.....	.....	.....
	GA-468	Inflatoplane	Recon., Rescue	1	22′	19′ 8″	7′	110	225	.....	550	Nelson 40 bhp. @ 3800 rpm	20	72	550	37	10,300	185	.....
	GA-466	Inflatoplane	Recon., Rescue	2	28′	19′ 3″	7′ 10″	154	290	.....	740	McCulloch	18	70	500	43	6,500	150	.....
Grumman Aircraft Eng'rg Corp. *Bethpage, N. Y.*	F9F-8T	Cougar	Trainer	2	34′ 6″	48′ 6″	12′ 1″	.....	.....	20,600	.....	1 P&W J48-P-8A @ 7,200 lb.t.	....	650+	.....	...	.....	.....	2 x 20
	F11F-1	Tiger	Interceptor	1	31′ 8″	40′ 10″	12′ 9″	250	13,428	21,174	24,078	1 Wr. J65-W-18 @ 10,500 lb.t.	....	M1+	.....	...	.....	.....	4 x 20
	F11F-1F	Super Tiger	Interceptor	1	31′ 8″	40′ 10″	12′ 9″	250	.....	.....	.....	1 GE J79-3A @ 14,800 lb.t.	....	1,000+	.....	...	55,000	.....	4 x 20
	S2F-1	Tracker	ASW	4	69′ 8″	42′ 3″	16′ 3″	.....	....	.....	.....	2 Wr. R1820-82 @ 1525 hp.	....	.....	.....	...	.....	.....	Sonobu
	S2F-3	Tracker	ASW	4	72′ 7″	43′ 6″	16′ 7″	.....	....	.....	.....	2 Wr. R1820-82 @ 1525	....	.....	.....	...	.....	.....	Sonobu
	WF-2	Tracer	AEW	4	69′ 8″	45′ 4″	16′ 10″	507	....	.....	.....	2 Wr. R1820 @ 1525 hp.	....	.....	.....	...	.....	.....	.....
	W2F-1	Hawkeye	AEW	5	80′ 7″	56′ 4″	16′	.....	.....	.....	49,500	2 All. T56-A8 @ 4,050 eshp.	....	.....	.....	...	.....	.....	.....
	AO-1AF	Mohawk	Observation	2	42′	41′	12′ 8″	330	9,295	11,672	14,679	2 Lyc. T53-L-3 @ 1,005 eshp.	....	316	3,000	...	25,000	200	.....
	A2F-1	.....	Attack	2	.....	.....	.....	.....	.....	.....	.....	2 P&W J52 @ 7,500 lb.t.	....	.....	.....	...	.....	.....	.....
Lockheed Aircraft Corp. *Burbank, Calif.*	F-104G	Super Starfighter	Interceptor	1	21′ 11″	54′ 9″	13′ 6″	.....	....	.....	.....	1 GE J79-3A @ 14,800 lb.t.	....	M2+	.....	...	70,000+	.....	1 x T-
	F-104F	Super Starfighter	Fighter Bomber	2	21′ 11″	54′ 9″	13′ 6″	.....	....	.....	.....	1 GE J79-3A @ 14,800 lb.t.	....	M2+	.....	...	70,000+	.....	1 x T-
	F-104C	Starfighter	Fighter	1	21′ 11″	54′ 9″	13′ 6″	.....	....	.....	.....	1 GE J79-7 @ 15,800 lb.t.	....	M2+	.....	...	70,000+	.....	1 x T-
	F-104D	Starfighter	Tac. Trainer	2	21′ 11″	54′ 9″	13′ 6″	.....	....	.....	.....	1 GE J79-7 @ 15,800 lb.t.	....	M2+	.....	...	70,000+	.....	1 x T-
	EC-121D	Warning Star	Radar Picket	31	123′ 5″	116′ 2″	27′	1,654	.....	.....	.....	4 Wr. R3350-91 @ 3,250 hp.	....	300	.....	...	.....	.....	None
	P2V-7	Neptune	ASW	..	101′ 4″	91′ 8″	29′ 4″	1,000	46,358	76,338	.....	2 Wr. R3350-32W @ 3,250 hp, also	....	345	.....	...	23,000	.....	6 x 20
												2 We. J34 @ 3,400 lb.t.	....	.....	.....	...	.....	.....	.....
	P3V-1	.....	ASW	10	99′	104′ 7″	33′ 1″	1,300	....	125,000	.....	4 All. T56-A-10W @ 4,500 eshp.	....	450+	.....	...	.....	.....	.....
	U-2	.....	Research	1	.....	.....	.....	.....	....	.....	.....	1 P&W J57 @ 18,000 lb.t.	....	.....	2–5,000	...	75,000+	.....	None
McDonnell Aircraft Corp. *St. Louis Mo.*	F-101B	Voodoo	Interceptor	2	40′	.....	18′	.....	....	.....	.....	2 P&W J57-P-55 @ 10,000+ lb.t.	....	1,000+	.....	...	.....	.....	GAR-9
	F4H-1	Phantom II	AW Interceptor	2	38′ 5″	56′	.....	.....	....	.....	.....	2 GE J79-2 @ 16,250	....	M2+	.....	...	.....	1,000	4 Spar
North American Aviation, Inc. *Los Angeles, Calif.*	B-70	Valkyrie	Bomber	4	.....	.....	.....	.....	....	.....	600,000	6 GE J93 @ 25,000+ lb.t.	....	M<3	.....	...	70,000+	7,000	.....
	F-86F	Sabre	Fighter-Bomber	1	37′ 1″	37′ 5″	14′ 7″	.....	....	.....	17,000	1 GE J47-27 @ 5,970 lb.t.	....	650+	.....	...	45,000+	500	6 x .50
	F-86H	Sabre	Fighter-Bomber	1	37′ 1″	38′ 8″	15′	.....	....	.....	.....	1 GE J73-3 @ 8,920 lb.t.	....	700	.....	...	45,000+	1,150	4 x 20
	F-86K	Sabre	Interceptor	1	37′ 1″	42′ 4″	15′	.....	....	18,500	20,347	1 GE J47-33 @ 7,650 lb.t.	....	650+	.....	...	45,000+	500+	4 x 20
	F-86L	Sabre	Interceptor	1	37′ 1″	42′ 4″	15′	.....	....	.....	.....	1GE J47-33 @ 7,650 lb.t.	....	650+	.....	...	45,000+	.....	.....
	F-100C	Super Sabre	Fighter	1	38′	47′	15′	.....	....	.....	.....	1 P&W J57-P-7 @ 10,000 lb.t.	....	1,000	.....	...	50,000+	500+	4 x 20
	F-100D	Super Sabre	Fighter-Bomber	1	38′	47′	16′	.....	....	.....	.....	1 P&W J57-P-21 @ 10,000+ lb.t.	....	1,000	.....	...	50,000+	500+	4 x 20
	F-100F	Super Sabre	Fighter-Bomber	2	39′	50′	16′	385.2	21,346	34,235	.....	1 P&W J57 @ 10,000+ lb.t.	1,185	1,000	20,000	...	50,000+	1,000+	2 x 20
	F-107A	.....	Research	1	36′ 7″	60′ 10″	19′ 8″	.....	....	.....	.....	1 P&W J75 @ 17,500 lb.t.	....	1,300+	.....	...	.....	.....	.....
	X-15	.....	Research	1	22′	50′	13′	200	.....	.....	31,275	1 XLR-99RM-I @ 57,000 lb.t.	....	M6	.....	...	.....	.....	None
	T-39	Saberliner	Utility	2	44′ 5″	43′ 8″	15′ 11″	342.5	9,199	15,330	.....	2 P&W J60 @ 3,000 lb.t.	850	575	5,550	87	40,000+	1,400	None
Columbus (Ohio) Division	FJ-4B	Fury	Fighter-Bomber	1	39′ 1″	36′ 6″	13′ 11″	338	....	19,900	.....	1 Wr. J65-W-16A @ 7,700 lb.t.	....	687	7,500	115	40,000+	.....	4 x 20
	A3J-1	Vigilante	AW Attack	2	53′	73′	20′	.....	.....	.....	.....	2 GE J79-2 @ 15,000 lb.t.	....	M2	.....	...	.....	.....	.....
	T2J-1	Buckeye	Trainer	2	36′	38′ 8″	14′ 9″	255	6,893	9,916	11,373	1 We. J34-46 @ 3,400 lb.t.	381	492	5,000	79	40,000	.....	2 x .5
Northrop Corp. *Hawthorne, Calif.*	T-38A	Talon	Trainer	2	25′ 3″	44′ 3″	12′ 10″	.....	7,200	.....	11,500	2 GE J85-5 @ 3,850 lb.t.	....	M1.2+	.....	...	55,000	.....	.....
	N-156F	Freedom Fighter	Fighter	1	26′ 5″	44′ 10″	13′ 2″	173.44	7,596	12,190	16,230	2 GE J85-5 @ 3,850 lb.t.	....	M2+	.....	...	52,200	.....	.....
	F-89J	Scorpion	AW Interceptor	2	56′	53′	17′	.....	.....	.....	40,000	2 All. J35-A-35 @ 15,000 lbs. w. aft. burner	....	600	.....	...	45,000	.....	2 MB
Republic Aviation Corp. *Farmingdale, N. Y.*	F-105D	Thunderchief	AW Fight.-Bomb.	1	34′ 11″	64′ 3″	19′ 8″	385	28,000	34,000	46,000	1 P&W J75-P19W @ 26,000+ lb.t.	....	M2+	.....	...	50,000+	.....	Vulca
	F-105B	Thunderchief	Fighter-Bomber	1	34′ 11″	63′ 11″	19′ 8″	385	....	.....	.....	1 P&W J75-P5 @ 20,000+ lb.t.	....	M2	.....	...	50,000+	.....	Vulca
Temco Electronics & Missiles Co.	TT-1	Pinto	Trainer	2	29′ 10″	30′	10′ 10″	150	3,139	4,400	4,400	1 Con. J69-T-2 @ 920 lb.t.	124	325	1,900	73	30,000	276	None

WERPLANT	PERFORMANCE						ARMAMENT	CHRONOLOGY				Remarks
r, make, model ax. rating, ea.	Normal fuel cap., gal.	Maximum speed, mph.	Initial rate of climb, fpm.	Stall speed, dirty, mph.	Service ceiling, ft.	Combat radius, mi.	Number, type and designation	First flight of prototype	First production contract	First deliveries to service	First flight, first production article	
@ 225 hp.	50	189	1,120	56	18,200	.....	2 x 30 cal. mg.; 6 rockets	Dec. '48	Nov. '52	Sept. '53	Oct. '53	
@ 225 hp.	50	188	1,100	58	18,100	.....	2 x 30 cal. mg.; 6 rockets	Dec. '48	June '54	Dec. '54	Nov. '54	
1B6 @ 340 hp.	230	230	1,580	84	25,500	.....	None	.....	July '56	Dec. '56	Nov. '56	
1B6 @ 340 hp.	168	230	1,463	84	23,800	.....	None	Oct. '58	Feb. '58	Feb. '59	Feb. '59	
A1A6 @ 340 hp.	230	239	1,300	80	27,000	.....	None	Aug. '58	June '59	Mar. '60	Feb. '60	
@ 6,000 lb.t.	....	600+	.....	...	40,000+	1,500+	2 x 20 mm. cannon; 20,000 lb. bombs	Dec. '47	Sept. '48	Oct. '51	June '50	Production discontinued Feb. '57; GAM-63 Rascal.
@ 10,000 lb.t.	....	600+	.....	...	50,000+	.....	.....	Apr. '52	Feb. '51	June '54	Aug. '54	Also J-57-P-29W & J-57-P-19W.
V @ 10,000 lb.t.	....	600+	.....	...	50,000+	.....	.....	.....	May '53	Oct. '57	Oct. '57	Also J-57-P-29W.
V @ 10,000 lb.t.	....	600+	.....	...	50,000+	.....	.....	.....	Aug. '56	June '58	June '58	
V @ 10,000 lb.t.	....	600+	.....	...	50,000+	.....	2 NAA GAM-77 Hound Dog	.....	Sept. '57	Oct. '58	Oct. '58	
@ 17,000 lb.t.	....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	
.....	....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	USAF-NASA Joint project.
@ 1,025 lb.t.	321	408	3,200	85	39,200	398	None	.....	Sept. '58	Nov. '59	Nov. '59	
1,400 lb.t.	550	485	3,650	87	46,000	708	.....	.....	.....	.....	.....	
@ 260 hp.	133	233	1,680	75	20,000	.....	None	Jan. '53	July '57	Dec. '57	Nov. '57	
@ 10,000+ lb.t.	....	1,100	.....	...	50,000+	.....	4 x 20 mm. cannon; 32 x 2.75" rockets	Mar. '55	June '53	Mar. '57	Sept. '55	Plus 2 Sidewinders.
@ 10,000+ lb.t.	....	1,100	.....	...	50,000+	.....	.....	Dec. '56	.....	Nov. '57	Dec. '56	
18,000 lb.t.	....	M<2	.....	...	50,000+	.....	4 x 20 mm. cannon; 32 x 2.75" rockets	Dec. '57	Dec. '57	.....	Aug. '58	Plus 2-4 Sidewinders.
18,000 lb.t.	....	M<2	.....	...	50,000+	.....	4 x 20 mm. cannon; 4 Sidewinders	.....	Oct. '58	June '60	Feb. '60	
10,000+ lb.t.	....	M1+	.....	...	50,000+	.....	GAR-98 Falcons; 24 x 2.75" rockets	Oct. '53	.....	.....	.....	
10,000+ lb.t.	....	M1+	.....	...	50,000+	.....	.....	Oct. '55	Apr. '54	Nov. '55	Oct. '55	Side-by-side seats.
00+ lb.t.	....	M2+	.....	...	60,000+	500	MB-1 Genie; GAR-3; GAR-4	Dec. '56	.....	.....	.....	F-106B is tandem two-seater.
@ 2,500 hp.	1,550	300	1,370	92	24,000	.....	None	Sept. '49	.....	.....	.....	
lb.t.	15,000	M2+	.....	...	65,000+	.....	Varied loads in external pods	Nov. '56	.....	Nov. '59	.....	Delta wing.
....	....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	
10,500 lb.t.	4,385	600+	.....	...	.....	.....	2 x 20 mm. cannon	Oct. '52	Feb. '51	Mar. '56	Sept. '53	Also photo; ECM, tanker and trainer versions.
@ 7,700 lb.t.	800	650+	.....	...	.....	.....	2 x 20 mm. cannon	June '54	Nov. '52	Oct. '56	.....	
0 lb.t.	....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	
@ 10,000 lb.t.	....	.....	.....	...	.....	.....	6 AAM-N-10 Eagles	.....	.....	.....	.....	
hp. @ 2600 rpm	....	.....	.....	...	.....	.....	.....	July '54	.....	Apr. '55	May '55	Ruddevator area 705 sq. ft.
0 hp. @ 2600 rpm	....	.....	.....	...	.....	.....	.....	Mar. '53	.....	Oct. '53	Nov. '53	Ruddevator area 952 sq. ft.
0 hp. @ 2800 rpm	....	.....	.....	...	.....	.....	.....	Feb. '55	.....	May '55	Dec. '55	Ruddevator area 952 sq. ft.
25 bhp. @ 2800 rpm	282	.....	.....	...	.....	.....	.....	July '58	.....	June '59	Dec. '59	Ruddevator area 940 sq. ft.
800 rpm	20	72	550	37	10,300	185	.....	1955	.....	1958	1958	
	18	70	500	43	6,500	150	.....	1957	.....	.....	.....	
@ 7,200 lb.t.	....	650+	.....	...	.....	.....	2 x 20 mm. cannon	.....	.....	.....	.....	
10,500 lb.t.	....	M1+	.....	...	.....	.....	4 x 20 mm. cannon	.....	.....	.....	.....	
800 lb.t.	....	1,000+	.....	...	55,000	.....	4 x 20 mm. cannon	.....	.....	.....	.....	
1525 hp.	....	.....	.....	...	.....	.....	Sonobuoy, depth charges, missiles	Dec. '52	.....	.....	.....	
1525	....	.....	.....	...	.....	.....	Sonobuoy, depth charges, missiles	May '59	.....	.....	.....	
5 hp.	....	.....	.....	...	.....	.....	.....	.....	.....	.....	Dec. '59	Overhead radome.
050 eshp.	....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	Overhead radome.
,005 eshp.	....	316	3,000	...	25,000	200	.....	Apr. '59	June '58	Sept. '60	Apr. '60	STOL capability.
lb.t.	....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	Low-level attack.
00 lb.t.	....	M2+	.....	...	70,000+	.....	1 x T-171 Vulcan; 2 x Sidewinders	Mar. '54	Mar. '59	Oct. '60	Sept. '60	
00 lb.t.	....	M2+	.....	...	70,000+	.....	1 x T-171 Vulcan; 2 x Sidewinders	.....	Mar. '59	Dec. '59	Jan. '60	
0 lb.t.	....	M2+	.....	...	70,000+	.....	1 x T-171 Vulcan; 2 x Sidewinders	.....	.....	Oct. '58	.....	World altitude record of 103,395.5 ft.
0 lb.t.	....	M2+	.....	...	70,000+	.....	1 x T-171 Vulcan	.....	.....	.....	.....	
,250 hp.	....	300	.....	...	.....	.....	None	.....	.....	Dec. '53	.....	WV-2E Navy version.
@ 3,250 hp, also	....	345	.....	...	23,000	.....	6 x 20 mm. cannon	May '45	Apr. '52	Apr. '54	Apr. '54	
b.t.	....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	Electra re-design.
4,500 eshp.	....	450+	.....	...	.....	.....	.....	.....	.....	.....	.....	
0 lb.t.	....	.....	2-5,000	...	75,000+	.....	None	.....	.....	.....	.....	Recon.
10,000+ lb.t.	....	1,000+	.....	...	.....	.....	GAR-98 Falcon; 2 MB-1 Genie	.....	.....	.....	.....	
0	....	M2+	.....	...	.....	1,000	4 Sparrow III; Sidewinders	May '58	.....	.....	.....	
+ lb.t.	....	M<3	.....	...	70,000+	7,000	.....	.....	.....	.....	.....	Restored to full weapon system status.
0 lb.t.	....	650+	.....	...	45,000+	500	6 x .50 cal. mg.; 16 x 5" HVAR	Apr. '53	Dec. '57	.....	Sept. '53	
lb.t.	....	700	.....	...	45,000+	1,150	4 x 20 mm. cannon	July '54	.....	.....	.....	NATO.
0 lb.t.	....	650+	.....	...	45,000+	500+	4 x 20 mm. cannon	.....	.....	.....	.....	Many F-86D conversions.
lb.t.	....	650+	.....	...	45,000+	.....	.....	May '53	Mid-'53	Sept. '54	.....	
0,000 lb.t.	....	1,000	.....	...	50,000+	500+	4 x 20 mm. cannon	Jan. '56	.....	Mid-'56	.....	
10,000+ lb.t.	....	1,000	.....	...	50,000+	500+	4 x 20 mm. cannon	Aug. '56	May '56	May '57	Mar. '57	Also Fighter-Trainer.
0+ lb.t.	1,185	1,000	20,000	...	50,000+	1,000+	2 x 20 mm. cannon	Sept. '56	.....	.....	.....	To NASA for high speed research.
0 lb.t.	....	1,300+	.....	...	.....	.....	.....	.....	.....	.....	.....	
7,000 lb.t.	....	M6	.....	...	.....	.....	None	Sept. '58	Oct. '58	.....	.....	Designed to fly over 100 mi. Altitude.
lb.t.	850	575	5,550	87	40,000+	1,400	None	Jan. '57	Jan. '59	Oct. '60	June '60	
7,700 lb.t.	....	687	7,500	115	40,000+	.....	4 x 20 mm. cannon; Sidewinders	.....	.....	.....	.....	
lb.t.	....	M2	.....	...	.....	.....	.....	.....	.....	.....	Aug. '58	Boundary layer control. Ground level ejection.
0 lb.t.	381	492	5,000	79	40,000	.....	2 x .50 cal. mg.; 14 x 2.75" rockets	Jan. '58	Sept. '56	July '59	Jan. '58	Ground level ejection.
lb.t.	....	M1.2+	.....	...	55,000	.....	.....	Apr. '58	Dec. '58	.....	Jan. '60	
lb.t.	....	M2+	.....	...	52,200	.....	.....	July '59	.....	.....	.....	
000 lbs. w. aft. burner	....	600	.....	...	45,000	.....	2 MB-1 Genie	.....	.....	1951	.....	
26,000+ lb.t.	....	M2+	.....	...	50,000+	.....	Vulcan; 20 mm.; Sidewinder; Bullpup	Oct. '55	.....	.....	June '59	Ext. navigation, radar, fire control system.
000+ lb.t.	....	M2	.....	...	50,000+	.....	Vulcan; 20 mm.; Sidewinder; Bullpup	Oct. '55	.....	May '58	Apr. '58	
lb.t.	124	325	1,900	73	30,000	276	None	Mar. '56	June '56	Nov. '57	Nov. '57	Tandem seats.

U.S. Civil and Military Transports

Manufacturer and Address	Model	Name	No. of crew	No. of passengers	Cargo capacity, lb.	Number, make, model of powerplants	Maximum speed, mph.	Best cruise speed, mph.	Landing speed, flaps and landing gear down, mph.	FAA field length takeoff, ft.	FAA field length landing ft.	Maximum still-air range, mi.	Weight empty, lb.	Maximum gross weight, lb.	Maximum landing weight, lb.	Wingspan	Overall length	Maximum height
Boeing Airplane Co. *Renton, Wash.*	707	Jet Stratoliner[1]	3	.....	.....	4 P&W JT3C-6[2]	610	600	.....	.....	.....	4,000	111,082	190,000	175,000	130′	128′	38′ 3″
	707-120	Jet Stratoliner	4	100–179	19,200	4 P&W JT3C-6[2]	610	589	.....	.....	.....	4,000	113,640	258,000	185,000	130′ 10″	144′ 6″	42′
	707-120B	Jet Stratoliner	3-4	100–179	19,200	4 P&W JT3D-1	.....	.....	.....	.....	.....	.....	120,734	258,000	185,000	130′ 10″	144′ 6″	38′ 2″
	707-220	Jet Stratoliner	4	100–179	19,200	4 P&W JT4A-3[3]	630	615	.....	.....	.....	4,000	117,400	248,000	175,000	130′ 10″	144′ 6″	42′
	707-320	Intercontinental	4-5	108–189	28,200	4 P&W JT4A-11[3]	630	610	.....	.....	.....	5,000	132,924	316,000	207,000	142′ 5″	152′ 11″	41′ 8″
	707-420	Intercontinental	4-5	108–189	28,200	4 R-R Co. 15[3]	630	606	.....	.....	.....	5,000	131,244	316,000	207,000	142′ 5″	152′ 11″	41′ 8″
	720	.....	3	88–149	16,680	3 P&W JT8D-1	610	600	.....	.....	.....	1,700	81,000	142,000	131,000	130′ 10″	136′ 2″	41′ 6″
	720-B	Jet Stratoliner	3-4	88–165	17,080	4 P&W JT3D-1	.....	.....	.....	.....	.....	.....	110,778	230,000	175,000	130′ 10″	136′ 2″	38′ 2″
	727	.....	3	70+	24,000	3 P&W JT8D-1	610	600	.....	.....	.....	1,700	81,000	142,000	131,000	108′ 7″	114′ 4″	33′ 9″
	735	.....	3-4	.....	104,000	4 P&W JT3D	.....	.....	.....	.....	.....	.....	.....	316,000	.....	.....	152′ 11″	38′ 8″
	KC-135A	Stratotanker	4	80+	50,000	4 P&W J57	600+	.....	.....	.....	.....	.....	.....	250,000	.....	130′ 10″	136′ 3″	38′ 5″
	C-135A	.....	4	80+	89,000	4 P&W J57	600+	.....	.....	.....	.....	.....	.....	250,000	.....	130′ 10″	136′ 3″	38′ 5″
	VC-137A[4]	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	130′ 10″	144′ 6″	38′ 8″
Convair Division General Dynamics Corp. *San Diego, Calif.*	880	.....	3	88–110	8,630	4 GE CJ805-3	615	...	138	6,500	5,720	3,200	81,800	184,500	132,800	120′	129′ 4″	36′
	880M	.....	3	88–110	8,630	4 GE CJ805-3B	615	...	138	5,750	4,860	3,750	86,820	191,000	155,000	120′	129′ 4″	36′
	990	.....	3	96–121	9,280	4 GE CJ805-23	640	...	125	5,350	4,770	4,300	110,820	239,000	180,000	120′	139′ 6″	39′ 6″
	990	Coronado	3	96–121	9,280	4 GE CJ805-23	640	...	125	5,350	4,770	4,300	110,820	244,200	180,000	120′	139′ 6″	39′ 6″
	440	Metropolitan	3	44–52	5,400	2 P&W R2800-CB-17	310	289	85	5,000	4,010	2,752	31,305	49,100	47,650	105′ 4″	79′ 6″	28′ 2″
	C-131A	Samaritan	3	.....	.....	2 P&W R2800-99W	312	.....	.....	.....	.....	.....	29,000	43,575	.....	91′ 9″	74′ 8″	27′ 3″
	C-131B	.....	...	.....	.....	2 P&W R2800-99W	295	.....	.....	.....	.....	.....	29,248	47,000	.....	105′ 4″	79′ 2″	28′ 2″
	YC-131C	.....	...	.....	.....	2 All. YT56-A-3	366	.....	.....	.....	.....	.....	.....	47,000	.....	105′ 4″	79′ 2″	28′ 2″
	C-131D	.....	3	.....	.....	2 P&W R2800-CB-16	314	.....	.....	.....	.....	.....	29,600	46,500	.....	105′ 4″	79′ 2″	28′ 2″
	R3Y2	Tradewind	6	.....	.....	4 All. T40-A10	350	.....	.....	.....	.....	.....	31,735	160,000	.....	145′ 9″	139′ 8″	51′ 5″
	R4Y1	.....	3	.....	.....	2 P&W R2800-52W	.....	.....	.....	.....	.....	.....	30,684	47,000	.....	105′ 4″	79′ 2″	28′ 2″
Douglas Aircraft Co., Inc. *Long Beach, Calif.*	DC-8	Series 10	3	116–176	20,850	4 P&W JT3C-6	.....	555	148	9,330	6,400	4,120	120,999	273,000	193,000	142′ 4″	150′ 6″	42′ 4″
	DC-8	Series 20	3	116–176	20,850	4 P&W JT4A-3	.....	588	148	8,200	6,400	4,280	123,757	276,000	193,000	142′ 4″	150′ 6″	42′ 4″
	DC-8	Series 30	3-5	116–176	20,850	4 P&W JT4A-3	.....	588	150	10,800	6,590	5,300	126,072	310,000	199,500	142′ 4″	150′ 6″	42′ 4″
	DC-8	Series 40	3-5	116–176	20,850	4 RR R. Co. 12	.....	593	...	9,870	6,590	5,430	124,369	.....	.....	142′ 4″	150′ 6″	42′ 4″
	DC-8	Series 50	3-5	116–176	20,850	4 P&W JT3D-3	.....	585	150	9,750	6,590	5,930	124,529	310,000	199,500	142′ 4″	150′ 6″	42′ 4″
	DC-8	Intercontinental	3-5	116–176	.....	4 RR R. Co. 10	.....	591	.....	.....	.....	.....	128,000	287,500	.....	139′ 9″	150′ 6″	42′ 4″
Fairchild Aircraft Division Fairchild Engine & Aircraft Corp. *Hagerstown, Md.*	F27	.....	3	40	10,030	2 R-R R Da. 6/mk 511	272	272	79	4,500	3,345	2,128	23,970	37,500	36,000	95′ 2″	77′ 1½″	27′ 6″
	F27A	.....	3	40	9,667	2 R-R R Da. 7/mk 528	300	300	79	3,420	3,345	1,955	24,520	37,500	36,000	95′ 2″	77′ 1½″	27′ 6″
Grumman Aircraft Engr. Corp. *Bethpage, L. I., N. Y.*	TF-1	Trader	2	9	3,500	2 Wr. R1820-82	.....	.....	.....	.....	.....	.....	16,858	24,649	.....	69′ 8″	42′	16′ 3″
Lockheed Aircraft Corp. *Marietta (Ga.)*	1329	Jet Star	2	8	2,421	4 P&W JT12A-6	565	545	120	5,000	4,300	2,650	19,095	40,069	28,695	53′ 8″	60′ 5″	20′ 6″
	C140	Jet Star	2	8	2,482	4 P&W J60-P-5	575	545	120	.....	.....	2,230	19,095	40,069	28,695	53′ 8″	60′ 5″	20′ 6″
	C140A	Jet Star	5	.....	.....	4 P&W J60-P-5	575	.....	.....	.....	.....	.....	20,569	40,069	28,695	53′ 8″	60′ 5″	20′ 6″
	C130A	Hercules	4	92	36,000	4 All. T56-A-1A or T56-A-9	375	350	110	.....	.....	1,840	59,500	124,200	124,200	132′ 7″	97′ 9″	38′ 4″
	GC-130A[5]	Hercules	6	.....	.....	4 All. T56-A-9	365	335	90	.....	.....	575[6]	62,500	124,200	124,200	132′ 7″	97′ 9″	38′ 4″
	RC-130A[7]	Hercules	8	24	.....	4 All. T56-A-9	375	350	112	.....	.....	.....	63,500	124,200	124,200	132′ 7″	97′ 9″	38′ 4″
	C-130B	Hercules	4	92	38,000	4 All. T56-A-7	375	350	115	.....	.....	2,210	66,700	135,000	135,000	132′ 7″	97′ 9″	38′ 4″
	SC-130B[8]	Hercules	8	92	38,000	4 All. T56-A-7	375	350	115	.....	.....	2,210	66,700	135,000	135,000	132′ 7″	97′ 9″	38′ 4″
	GV-1	Hercules	5	92	51,000	4 All. T56-A-9	365	340	115	.....	.....	.....	70,400	135,000	135,000	132′ 7″	97′ 9″	38′ 4″
	C-130D	Hercules	4	92	30,600	4 All. T56-A-1A or T56-A-9	350	325	100	.....	.....	1,500	65,500	124,200	124,200	132′ 7″	97′ 9″	39′ 1″
	C-130E	Hercules	4	92	32,700	4 All. T56-A-7	365	345	115	.....	.....	3,740	69,200	155,000	155,000	132′ 7″	97′ 9″	38′ 4″
	C-130BL[9]	Hercules	4	92	34,400	4 All. T56-A-7	360	335	115	.....	.....	2,060	73,300	135,000	135,000	132′ 7″	97′ 9″	39′ 1″
Burbank, Calif. Div.	188	Electra	3-4	66–98	.....	4 All. 501-D-13	450	406	130	5,250	4,960	3,400	57,300	116,000	95,650	99′	104′ 6″	33′

[1] Prototype.
[2] Wet engine.
[3] Dry engine.
[4] Three aircraft ordered for USAF Special Mission Squadron.
[5] Drone launcher.
[6] Combat radius, includes four-hours loiter.
[7] Photographic survey missions.
[8] U. S. Coast Guard search and rescue version.
[9] Navy ski transport.



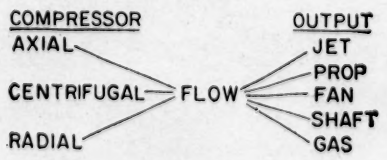
NORTHEAST CONVAIR 880

U. S. Gas Turbine Engines

Manufacturer and Address	Designation	Type**	No. of compressor stages axial, centrifugal	No. of turbine stages	No. of combustors	Max. power at S. L.	Specific fuel comsumption at max. power, lb. hr. lb. t. or eshp.	Compression ratio at max rpm.	Max. envelope diameter, in.	Max. envelope length, in.	Dry weight, less tailpipe, lb.	Remarks
Avco Manufacturing Corp. Lycoming Division *Stratford, Conn.*	T53-L-1A	ACFS	5, 1	1	....	860 shp.	0.735	6.0	23	47.61	484	Bell HU-1A, Kaman H-43B
	T53-L-3	AFP	5, 1	1	....	960 shp.	0.655	6.0	23	58.40	530	Grumman AO-1
	T53-L-5	ACFS	5, 1	1	....	960 shp.	0.664	6.0	23	47.60	485	Bell HU-1B
	T53-L-7	AFP	5, 1	1	....	1,100 shp.	0.641	6.0	23	47.60	522	
	T53-L-9	ACFS	5, 1	1	....	1,100 shp.	0.652	6.0	23	47.61	485	Bell 204
	T55-L-5	ACFS	7, 1	1	....	2,200 shp.	0.629	6.3	24.25	45.21	570	Vertol YHC-1B
Boeing Airplane Co. *Seattle, Wash.*	502-10S	CFS	1	2	2	360 shp.	0.90	4.47	24	41.5	325	Radioplane RP-77D
	502-11B	CFG	2	2	2	205 air hp.	.....	3.5	28.5	50	350	Compressed air output
	T60 [520-2]	CFS	1	2	2	430 shp.	0.72	6.25	25.5	57.32	325	Helicopter Type
	T50-30-4	CFS	1	2	2	270 shp.	1.02	4.40	24.0	41.5	310	Turboshaft
	502-10W	CFS	1	2	2	325 shp.	0.89	4.56	24.0	41.5	325	Turboprop
	502-10WA	CFS	1	2	2	285 shp.	0.93	4.35	24.0	41.5	300	Turboshaft
	520-4	CFS	1	2	2	475 shp.	0.71	6.52	25.5	68.67	325	Turboprop
	520-6	CFS	1	5	2	550 shp.	0.65	6	25.5	57.32	250	Turboshaft
	520-8	CFS	1	2	2	550 shp.	0.65	6	25.5	68.67	275	Turboprop
Chrysler Corp. *Centerline, Mich.*	CR2A	ACFS	1	2	1	160 hp.	0.51	4.25	.....	36.5	450	Low SFC at low output
Continental Aviation & Eng'g. Corp. *Detroit, Mich.*	J69-T-25	CFJ	1	1	1	1,025 lb. t.	1.14	.....	24.9	50	364	Cessna T-37B; CJ69-1025
	J69-T-29	ACFJ	1, 1	1	1	1,700 lb. t.	1.10	.....	.....	46.3	335	Ryan Q-2C
	J69-T-39	ACFJ	3	2	1	2,550 lb. t.	0.99	6.1	22.3	44	385	Target Missile Engine
	T72-T-2(217-5A)	ACFP	1, 1	3	1	500 bhp.	0.67	.....	19.38	43.25	245	6,000 rpm. Turboshaft
	217-6A	ACFS	1, 1	3	1	500 bhp.	0.67	.....	19.38	48.63	245	2,100 rpm Turboprop
	141	CFC	1	1	1	191 air hp.	.....	.....	.....	.....	197	For pressure-jet helicopter.
	CJ69-1400	ACFJ	2	1	1	1,400 lb. t.	1.04	5.1	22.3	44	370	Aircraft Engine
	356-23	ACFJ	3	2	1	2,400 lb. t.	0.98	6.1	22.3	47	410	Aircraft Engine
Curtiss-Wright Corp. Wright Aeronautical Div. *Woodridge, N. J.*	J65-W-5	AFJ	13	2	1	7,200 lb. t.	.....	.....	37.5	109	2,750	
	J65-W-7	AFJ	13	2	1	7,800 lb. t.	.....	.....	37.5	115	2,795	
	J65-W-16-16A	AFJ	13	2	1	7,700 lb. t.	.....	.....	37.5	113	2,757	
	J65-W-18	AFJ	13	2	1	10,500 lb. t.	.....	.....	37.5	181	3,485	
General Electric Co. Aircraft Gas Turbine Div. *Cincinnati, Ohio*	J47-25	AFJ	12	1	8	7,200 lb. t.	1.06	5.35	36.75	145	2,554	B-47E, water/alcohol injection
	J47-27	AFJ	12	1	8	5,970 lb. t.	1.06	5.35	36.75	148	2,607	F-86F, non-after burning
	J47-33	AFJ	12	1	8	7,650 lb. t.	1.15	5.35	36.75	228	3,196	F-86D, after burner
	J73-3	AFJ	12	2	8	8,920 lb. t.	0.917	7.0	36.75	147.2	3,650	F-86H, non-after burning
	J79-2	AFJ	17	3	10	16,250 lb. t.	1.93	12	38.31	204	3,620	F4H-1, A3J
	J79-3A	AFJ	17	3	10	14,800 lb. t.	2.04	12	38.31	204	3,255	F-104A, B, Regulus II
	J79-5A	AFJ	17	3	10	15,600 lb. t.	2.02	12	38.31	204	3,570	B-58
	J79-7	AFJ	17	3	10	15,800 lb. t.	1.97	12	38.31	204	3,375	CF-104, F-104C, D, G; F11F-1F
	J79-8	AFJ	17	3	10	15,800 lb. t.	.....	12	38.31	204	3,200	F4H-1, A3J
	J79-11A	AFJ	17	3	10	15,800 lb. t.	1.97	12	38.31	204	3,485	F-104G
	J93-3	AFJ	.....	.....	.....	.....	.....	.....	.....	.....	.....	B-70
	X211 Nuclear	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Convair NX-2 Bomber
	TF 35	AFF	17	3	10	15,000 lb. t.	.....	12	32[1] 53[2]	144	3,700	
	CJ-805-3	AFJ	17	3	10	11,200 lb. t.	0.806	13	32	189	2,800	Convair 880; Length w. rev/suppressor
	CJ-805-3B	AFJ	17	3	10	11,650 lb. t.	0.806	13	32	189	2,815	Convair 880M;length w. rev/suppressor
	CJ-805-23	AFF	17	3	10	16,100 lb. t.	0.575	13	31[1] 53[2]	139	3,730	Aft Fan, Convair 990, with reverser
	CJ-805-23C	AFF	17	3	10	16,100 lb. t.	0.575	13	32[1] 53[2]	166	3,835	Aft Fan, Caravelle VII, with reverser
General Electric Co. Small Aircraft Engine Dept. *Lynn, Mass.*	T58-GE-6	AFS	10	2+1	1	1,050 shp.	0.64	8.3:1	16	55	271	HU2K; HSS-2; YHC-1A; M224(VTOL); K-16 (VTOL)
	T58-GE-8	AFS	10	2+1	1	1,250 shp.	0.61	8.3:1	16	55	285	First step growth
	CT58-100	AFS	10	2+1	1	1,050 shp.	0.64	8.3:1	16	55	280	T58-6; Vertol 107, Model II; S-61, S-62
	CT58-110	AFS	10	2+1	1	1,250 shp.	0.61	8.3:1	16	55	295	First step growth of CT 58-100
	J85-GE-5	AFJ	8	2	1	3,850 lb. t.	2.20	7:1*	20.2	108.8	538	Northrop T38A, N156F, Q4B
	J85-GE-7	AFJ	8	2	1	2,450 lb. t.	0.975	7:1*	17.5	39.2	326.5	McDonnell GAM-72
	CJ610-J	AFJ	8	2	1	2,850 lb. t.	0.99	7:1*	17.7	39.7	355	
	CJ612-2B	AFJ	8	2	1	2,340 lb. t.	0.89	7:1*	17.7	39.7	355	
	CF700-2	AFF	8	2	1	4,000 lb. t.	0.69	7:1*	34	64	615	Aft turbofan
	CF700-2B	AFF	8	2	1	4,200 lb. t.	0.686	7:1*	34	64	615	Aft turbofan
	T64-GE-2	AFS	14	2+2	1	2,650 shp.	0.506	12.6:1	30	91	854	
	T64-GE-4	AFP	14	2+2	1	2,700 shp.	0.495	12.6:1	36	113	1,079	Reduction gear below engine centerline
	T64-GE-6	AFS	14	2+2	1	2,650 shp.	0.506	12.6:1	30	83	713	Direct drive configuration
	T64-GE-8	AFP	14	2+2	1	2,700 eshp.	0.495	12.6:1	46	113	1,083	Reduction gear above centerline
Garrett Corp. AiResearch Mfg. Co. *Phoenix, Ariz.*	GTCP100-52	CAFG	2	1+1	6	358 ahp.	1.23	5:1/3:1	22.24	56.51	386	
	GTCP85-106	CFS	2	1	1	268.5 hp.	1.04	3:87	31.5	39	300	
	GTC85-108	CFG	2	1	1	222 ahp.	1.13	3:65	31.4	38	262	Helicopter type
	GTC85-135	CFG	2	1	1	210 ahp.	1.19	3:65	34.2	39	230	
	GTP-34	CFS	1	1	1	55 hp.	1.35	2:6	17.75	19.75	53	60 °F Day
	GHC-105-1	CAFG	2	1+1	6	199.5 ahp.	1.26	7:8	6	10	4,000	
General Motors Corp. Allison Div. *Indianapolis, Ind.*	J33-A-41	CFJ	1	1	14	5,100 lb. t.	1.14	4:35	52	156	1,520	
	T56-A-1	AFP	14	4	6	3,750 eshp.	0.54	9:25	40	145	1,645	
	T56-A-7	AFP	14	4	6	4,050 eshp.	.....	.....	.....	.....	.....	
	T56-A-8	AFP	14	4	6	4,050 eshp.	.....	.....	.....	.....	.....	
	T56-A-9	AFP	14	4	6	3,750 eshp.	.....	.....	.....	.....	.....	
	T56-A-10W	AFP	14	4	6	4,585 eshp.	.....	.....	.....	.....	.....	Water/alcohol injection
	501-D13	AFP	14	4	6	3,750 eshp.	0.54	9:25	36	145	1,645	Lockheed Electra
	T63	ACFPG	7, 1	.....	1	250 eshp.	0.70	.....	19.5	38.5	147	
	T63	ACFS	7, 1	.....	1	250 hp.	0.70	.....	19.5	34.6	128	Max. width 15.8".

Legend:

* *TYPE



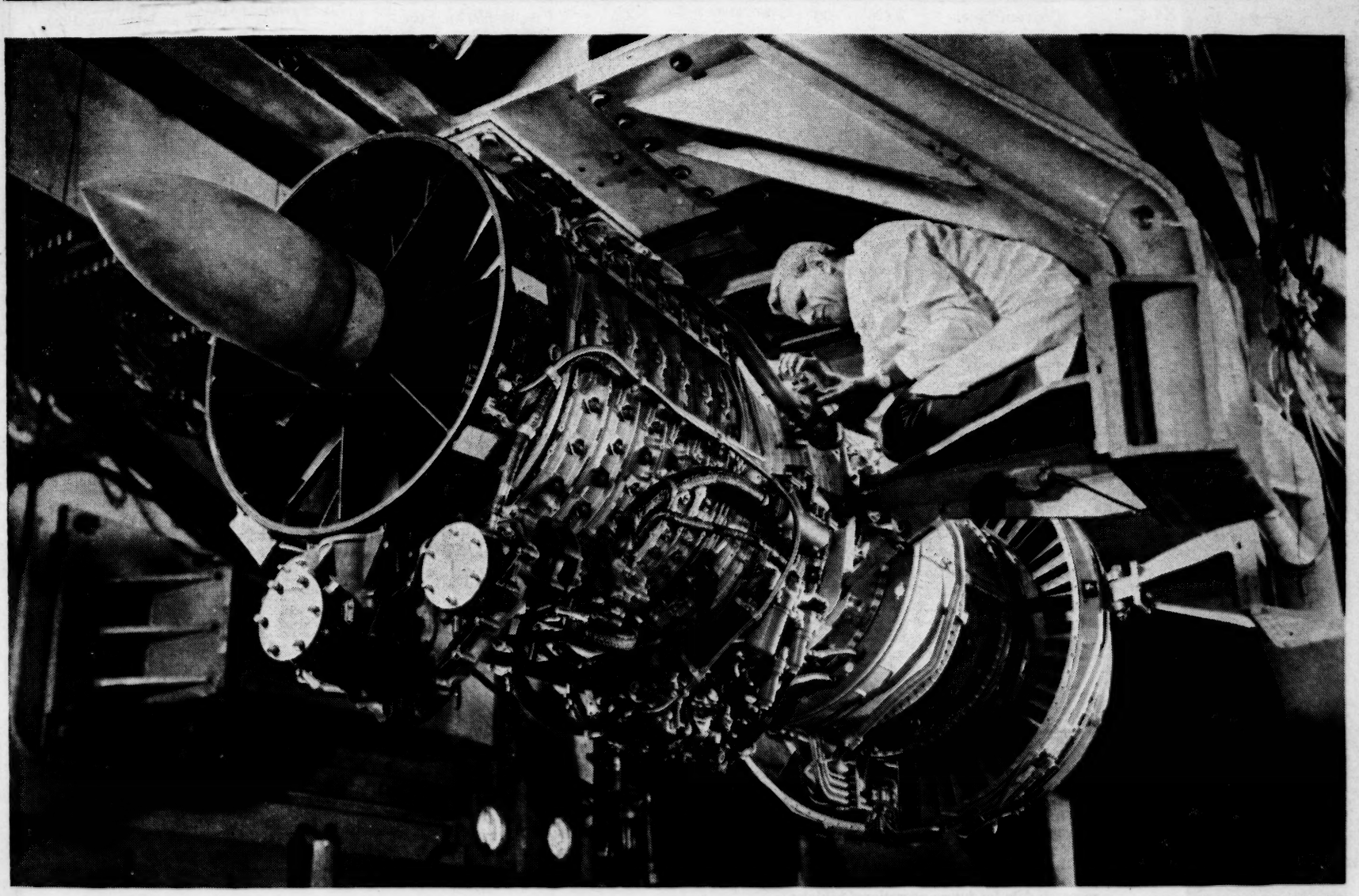
*—Approximate
Eshp.—Equivalent shaft horsepower
Lb. t.—Pounds thrust
Shp.—Shaft horse power
[1]—Basic engine
[2]—Aft fan

Manufacturer and Address	Designation	Type**	No. of compressor stages axial, centrifugal	No. of turbine stages	No. of combustors	Max. power at S. L.	Specific fuel comsumption at max. power, lb. hr. lb. t. or eshp.	Compression ratio at max rpm.	Max. envelope diameter, in.	Max. envelope length, in.	Dry weight, less tailpipe, lb.	Remarks
Solar Aircraft Co. San Diego, Calif.	T62	CFS	1	1	1	80 shp.	1.10	3.42	15.6	24.7	5.20	Single shaft, constant speed; T66 variable speed
United Aircraft Corp. Pratt & Whitney Division E. Hartford, Conn.	JT3C-6	AFJ	16	3	8	13,500 lb. t.	0.775	13	38.88	.....	4,234	
	JT3C-7	AFJ	16	3	8	12,000 lb. t.	0.785	13	38.88	.....	3,495	
	JT3C-12	AFJ	16	3	8	13,000 lb. t.	0.82	13	38.88	.....	3,550	
	J57-P-20	AFJ	16	3	8	18,000 lb. t.	2.35	13	38.9	253	4,750	JT3C-26
	J57-P-43WB	AFJ	16	3	8	13,750 lb. t.	0.95	13	38.9	167.33	3,870	JT3C-2
	JT3D-1	AFF	15	4	8	17,000 lb. t.	0.52	13	53	.....	4,065	Civil TF-33 Turbofan
	JT3D-3	AFF	15	4	8	18,000 lb. t.	0.535	13	53	.....	4,170	
	TF33-P-3	AFF	15	4	8	17,000 lb. t.	0.52	13	53	.....	3,900	
	TF33-P	AFF	15	4	8	18,000 lb. t.	0.535	13	53	.....	4,170	JT3D-4
	JT4A-9; -10	AFJ	15	3	8	16,800 lb. t.	0.81	12	43	144.1	5,050	−10 weight 4,845 lb.
	JT4A-11; -12	AFJ	15	3	8	17,500 lb. t.	0.84	12	43	.....	5,100	−12 weight 4,895 lb.
	J75-P	AFJ	15	3	8	17,500 lb. t.	0.84	12	43	.....	4,895	JT4A-14
	J75-P-19W	AFJ	15	3	8	26,500 lb. t.	2.20	12	43	259.3	5,960	After burner water inj., JT4A-29
	JT8D-1	AFF	13	4	9	14,000 lb. t.	0.64	.....	44	.....	2,980	
	JT12A-6	AFJ	9	2	8	3,000 lb. t.	0.96	6.5	21.9	76	436	
	JT12A-8	AFJ	9	2	8	3,300 lb. t.	0.995	6.5	.....	.....	465	
	J60-P-3	AFJ	9	2	8	3,000 lb. t.	0.96	6.5	21.9	76	436	
	J60-P	AFJ	9	2	8	3,300 lb. t.	0.995	6.5	21.9	76	465	JT12A-7
	JFTD12A-3	AFS	9	2.2	8	4,050 shp.	.....	6.5	.....	.....	870	Free turbine shaft drive
	PT6A-3	ACFP	4	.....	1	500 eshp.	0.69	6	18.45	52	250	
	PT6B-3	ACFS	4	2.2	1	500 shp.	0.70	6	18.45	48.5	225	
	J58	AFJ	.....	.....	....	30,000+ lb. t.	.....	.....	.....	.....	.....	JT11
	J52	.....	.....	.....	.....	7,500 lb. t.	.....	.....	.....	.....	.....	JT8
	YTF33-P-1	AFF	15	4	8	16,000 lb. t.	0.61	13.1	53	.....	4,350	TF33-P-3
	YTF60-P	AFJ	9	2	8	4,025 lb. t.	2.42	6.5	21.9	.....	651	JT12A-21
	JTF10A-1	AFF	.....	.....	....	8,250 lb. t.	.....	.....	38	128.4	2,110	TF30-P-2

Legend:

****TYPE**

*—Approximate
Eshp.—Equivalent shaft horsepower
Lb. t.—Pounds thrust
Shp.—Shaft horse power
1—Basic engine
2—Aft fan



CARAVELLE MARK VII'S GE CJ-805-23C ENGINE

U. S. STOL & VTOL Aircraft

Manufacturer and Address	General Data: Designation	Type	No. of seats	Dimensions: Span	Length	Height	Wing area, sq. ft.	Weights: Empty weight, lb.	Gross weight, lb.	Powerplant: Number, make, model and max. power, ea.	Rotor-propeller diameter	No. of propellers	Service ceiling, ft.	Maximum speed, mph	Remarks
Bell Aerosystems Co. *Buffalo, N. Y.*	X-14	Deflected jet	1	34′	27′	9′	.....	.....	.....	2 AS Viper	.....	None	.....	.....	VTOL flight cycle May 24, 1958.
	D-188A	Tilt jets	1	.....	.....	.....	.....	.....	.....	8 GE J58 @ 2,000 lb. t.	.....	None	.....	M2+	Twin jets at each wingtip; 2 in fuselage; 2 in tail.
	D-190	Ducted Fan	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Bell Helicopter Corp. *Fort Worth, Texas*	XV-3	Tilt rotor	4	30′	30′	13′ 6″	120′	3,490	4,700	1 P&W R985 @ 400 hp.	23′	2	7,400[2]	184	Rotor diameter (2) 23 ft
Bensen Aircraft Corp. *Raleigh, N. C.*	B-10	Prop-Copter	1	7′ 2″[1]	12′	4′ 6″	.....	350	650	2 McCulloch 4318-E72 hp.	4′ 3″	2	.....	60	First flight Aug. 6, '58.
	B-8m	Gyrocopter	1	21′	21′	6′ 4″	.....	250	500	1 McCulloch 4318-E72 hp.	21′	.....	16,500	85	
Chrysler Corp Defense Ops. Div. *Detroit, Mich.*	VZ-6	Ducted fan	1	10′[1]	23′	4′ 6″	.....	.....	2,000	1 Lyc. @ 380 hp.	8′ 6″	2	.....	.....	Rigid fixed-pitch rotor props.
Collins Radio Co. *Cedar Rapids, Iowa*	**Aerodyne**	**Ducted fan**	...	.....	42″	.....	.....	.....	.....	2 Con. @ 213 hp.	.....	.....	.....	.....	Duct inside diameter 7.5 ft.
De Lackner Helicopters, Inc. *Mt. Vernon, N. Y.*	DH-4 Aerocycle	Platform Veh.	1	15′	.....	7′	600′	260	470	1 Kiek. Mercury @ 40 hp.	15′	2	4,000	50+	Several on bailment to universities.
	DH-5 Aerocycle	Platform Veh.	1	15′	.....	7′	600′	220	430	1 Kiek. Mercury @ 40 hp.	.....	2	4,000	50	
Doak Aircraft Co., Inc. *Torrance, Calif.*	VZ-4DA	Tilt ducts	2	25′	32′	10′	.....	2,000	2,700	1 Lyc. T53 @ 840 shp.	.....	2	.....	.....	600 lb. useful load. In flight test at NASA, Langley.
Hiller Aircraft Corp. *Norwood, Mass.*	L-28A	STOL High wing	5	39′	30′	8′ 10″	231	2,037	3,000	1 Lyc. GO. 480 @ 295 hp.	96″	1	22,500	189	In production.
Hiller Aircraft Corp. *Palo Alto, Calif.*	X-18	Tilt wing	2	48′	63′	24′ 7″	.....	33,000	.....	2 All. YT40-A-14	192″	2	.....	250	Testbed for USAF.
Kaman Aircraft Corp. *Bloomfield, Conn.*	K-16B	.....	...	34′	38′ 4″	14′ 4″	228	.....	.....	2 GE YT58-6 @ 1,050 shp.	168′	2	.....	.....	Navy flight research a/c.
Lockheed Aircraft Corp. *Marietta, Georgia*	BLC-130	Boundary Layer	92	132′ 7″	98′ 10″	38′ 4″	1,745	73,150	135,000	4 All. T56A-7 @ 4050 eshp. and 4 Con. 356-17/Air Flow 20 lb./sec./ea.	13.5	4	37,000	360	Testbed flying.
Mayer Aircraft Corp. *Marlton, N. J.*	Paraplane 110	Boundary layer	1	20′ 7″	21′	.....	111	780	1,280	1 Lyc. O-320 @ 150 hp.	.....	1	23,000	165	Prototype flying.
	Paraplane 443	Boundary layer	4	27′ 11″	22′ 11″	9′ 6″	.....	1,200	2,200	1 Lyc. O-360 @ 180 hp.	.....	1	21,500	171	Project.
McDonnell Aircraft Corp. *St. Louis, Mo.*	XV-1	Convertiplane; unloaded rotor.	3	26′	30′	10′ 8″	.....	.....	.....	1 Con. @ 550 hp.+tip jets	.....	.....	.....	.....	Translated Apr. 1955.
Piasecki Aircraft Corp. *Philadelphia, Pa.*	VZ-8P	Ducted fan	1	9′ 5″	26′ 1″	6′ 8″	.....	2,000	2,350	1 Con. Artouste 11B @ 425 shp.	.....	.....	.....	.....	Tactical ground support.
	PA-59H	Ducted fan	4	9′ 3″	24′ 5″	5′ 10″	.....	2,600	3,670	2 Con. Artouste 11B @ 425 shp.	.....	.....	.....	.....	VZ-8P with ground powered wheels.
	PA-4A	Quadrotor	...	22′ 3″	22′ 3″	6′ 8″	.....	.....	2,500	Lyc. VO-435-A1B @ 260 hp.	.....	.....	.....	.....	Radio-controlled drone.
	PA-101	Rotor Helicopter	...	.....	64′ 6″	16′ 4″	.....	.....	25,000	3 GET 58-6 @ 1050 hp.	65′	.....	.....	143	Military and commercial.
	PA-94	STOL High wing	...	76′	71′	29′	.....	.....	44,000	4 GET 58-8 @ 1250 hp.	.....	.....	.....	.....	Deflected slipstream STOL.
Robertson Aircraft Corp. *Ft. Worth, Texas Also, Fla.*	M-258	Vectored slipstream and Pure Jet	5–7	24′	33′	8.3′	144	3,400	8,000	2 XSO-580 Lyc. & 2 Tilt J-46 Turbojets	106″	2	.....	.....	First flight, 1958.
	M-400, SRQ	Vectored slipstream	5–7	40′	37′	.....	.....	2,600	5,000	.....	.....	.....	.....	.....	Currently under Army Flight Test Contract.
	M-410 SRV	VTOL	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Swept wing outer panels minimize trim change between hovering and forward flight.
	M-233	Tilt-jet VTOL	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Supersonic test bed. Engines tilt pyramidally to provide three-axis hover control.
Lehigh Acres, Fla.	Model CD-3	Tip rocket	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Test bed.
	Model 330	SCAT	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Survival craft.
Ryan Aeronautical Co. *San Diego, Calif.*	X-13 Vertijet	Mod. tail Sitter	1	21′	24′	15′	.....	.....	.....	1 R-R Avon @ 10,000 lb. t.	N.A.	None	.....	.....	Operates from platform.
	VZ-3RY	Vectored slipstream	1	23′ 5″	27′ 8″	10′ 8″	.....	.....	2,600	1 Lyc. T53 @ 850 shp.	.....	2	.....	.....	
Sikorsky Aircraft Division United Aircraft Corp. *Stratford, Conn.*	S-57	Convertiplane	...	.....	.....	.....	.....	.....	.....	1 P&W JT12 @ 5,000 lb. t.	.....	.....	.....	575	Single-blade, retracting rotor.
	.....	Unloaded rotor	40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Projected; 300 naut. mi. range.
Vanguard Aircraft Air & Marine Corp. *Paoli, Pa.*	Model 2D	Fan-in-wing with ducted pusher prop.	2	22′	30′ 5″	9′ 4″	.....	.....	3,100	1 Lyc. O-540 @ 265 hp. 1 Lyc. T53 @ 825 shp.	6′ 6″	2	.....	.....	Testbed. Wing-buried rotor-props. Now in test phase.
Vertol Division Boeing Airplane Co. *Morton, Pa.*	VZ-2	Tilt wing	2	24′ 11″	26′ 5″	10′	110	2,500	3,200	1 Lyc. T53 @ 825 shp.	9′ 6″	2	.....	.....	Numerous conversions made.

Military definition of VTOL aircraft is one which can clear a 50-ft. obstacle 50-ft. from start of takeoff; STOL aircraft is one which can clear a 50-ft. obstacle 500 ft. from start to takeoff. Many VTOL aircraft can also function as STOL types, carrying higher payloads in function as STOL types, carrying higher payloads in latter configuration. Army-Navy-Air Force VTOL and STOL projects embrace wide variety of propulsion and lift schemes. Most are test beds providing flight research data for future operational vehicles.

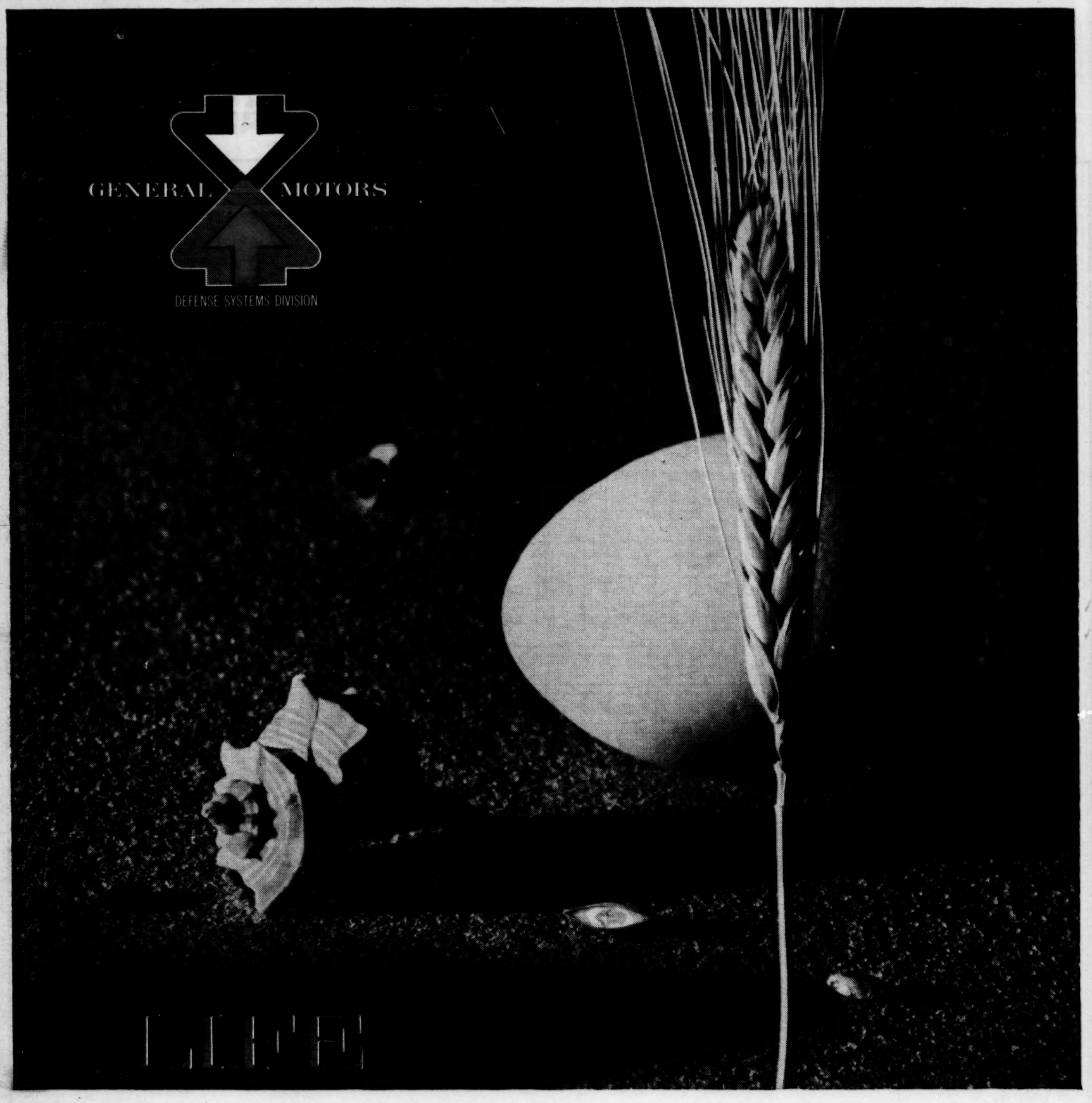
Abbreviations:
All. — Allison.
AS — Armstrong-Siddeley (now Bristol Siddeley).
Con. — Continental
GE — General Electric
Lyc. — Lycoming
N.A. — Not applicable.
P&W — Pratt & Whitney Aircraft.
Kiek. — Kiekhaefer.
RR — Rolls-Royce.

[1] U.S. Army Flying Platforms; dimension given (span) is width of vehicle.
[2] Hovering ceiling in ground effect.

U.S. Civil and Military Rotary-Wing Aircraft

Manufacturer and Address	Model Number	Designation	No. of crew	No. of passengers	Cargo capacity, lb.	Dimensions: Rotor diameter	Dimensions: Max. length blades unfolded	Dimensions: Over-all height to top of rotor	Weights: Weight empty, lb.	Weights: Max. gross wt., lb.	Powerplant: No., make, model and max. rating	Performance: Max. speed, mph., at altitude, ft.	Performance: Hovering ceiling in ground effect, ft.	Performance: Normal still-air range mi.	Remarks
Bell Helicopter Company *Ft. Worth, Texas*	47G-2	Trooper	1	2	886	35′ 1″	41′ 5″	9′ 5″	1,564	2,450	1 Lyc. VO435 @ 200 hp.	100 @ S.L.-1,400	10,850	238	Army H-13H.
	47G-2A	Trooper	1	2	1,212	37′ 2″	43′ 2″	9′ 3″	1,638	2,850	1 Lyc. VO435 @ 240 hp.	105 @ S.L.	8,500	225	Based on 2,450 lb. GW.
	HTL-7	.....	1	1	574	37′ 2″	43′ 4″	9′ 4″	1,916	2,565	1 Lyc. 0435-6 @ 240 hp.	103 @ N.R.	8,200	154	Navy Instrument Trainer.
	47H	Bellairus	1	2	.....	.....	41′ 3″	9′ 4″	1,499	2,350	1 AM6V4-200-C32 @ 200 hp.	98 @ S.L.-1,400	4,300	211	Commercial only.
	47G-3	.....	1	2	1,250	37′ 2″	43′ 2″	9′ 3″	1,600	2,850	1 AM6VS-335 @ 240 hp.	105 @ S.L.	15,800	200	Based on 2,650 lb. GW.
	47J	Ranger	1	3	1,210	37′ 2″	43′ 4″	9′ 4″	1,640	2,565	1 Lyc. VO-435 @ 220 hp.	105 @ S.L.-7,000	7,400	222	Navy HUL-1; AF H-13J; CG HUL-1G.
	47J-2	Ranger	1	3	1,120	37′ 2″	43′ 4″	9′ 3″	1,730	2,850	1 Lyc. VO-540 @ 260 hp.	105 @ S.L.	9,200	260	
	HU-1A	Iroquois	1	4–9	3,261	44′	53′	11′ 4″	3,939	7,200	1 Lyc. T-53 @ 770 shp.	121 @ S.L.	15,000	248	
	HU-1B	Iroquois	1	7–9	4,131	44′	53′	11′ 4″	4,369	8,500	1 Lyc. T-53 @ 960 shp.	128 @ S.L.	15,400	288	
	HUL-1M	.....	1	3	.....	37′ 2″	43′ 2″	9′ 3″	.....	.....	1 Allison T-63 @ 250 shp.	.....	.....	.....	2 Exp. a/c. Flt. Test status. Navy.
Bensen Aircraft Corp. *Raleigh, N. C.*	B-8	Gyroglider	1	1	300	20′	20′	6′ 4″	105	475	.....	90 @ S.L.	.....	....	
	B-8W	Hydroglider	1	1	.....	20′	20′	7′ 4″	130	500	.....	60	.....	....	
	B-8B	Gyroboat	1	2	.....	21′	21′	5′ 9″	135	650	.....	60	.....	....	
	B-9	Little Zipster	1	0	.....	22′	22′	11′ 6″	385	800	1 Keikhaefer Mk. 78 @ 70 hp.	65 @ S.L.	9,000	100	
Brantly Helicopter Corp. *Phila., Pa.*	B-2	.....	1	1	50	23′ 11″	27′ 9″	6′ 11″	980	1,600	1 Lyc. VO360-A1A @ 180 hp.	100 @ S.L.	4,000	300	All-metal.
Cessna Aircraft Co. *Wichita, Kans.*	.....	Skyhook	1	3	.....	35′	42′ 6″	8′ 5″	2,080	3,100	1 Con. FSO526 @ 270	122 @ S.L.	9,600	260	Commercial version.
Doman Helicopters, Inc. *Danbury, Conn.*	D-10	.....	1	7	1,900	48′	58′ 6″	10′ 6″	3,327	5,500	1 Lyc. ISO-720 @ 400 hp.	104 @ S.L.	5,500	354	Supercharged engine.
	D-10A	.....	1	7	1,900	48′	58′ 6″	10′ 6″	3,327	5,500	1 Lyc. IO-720	.....	.....	....	
Gyrodyne Co. of America *St. James, N. Y.*	GCA-41A	YRON-1	1	0	60	17′	17′	8′	430	725	1 Porsche YO-95-2 @ 62 hp.	68 @ S.L.	4,900	59	
	GCA-41B	YRON-1	1	0	125	17′	17′	8′	395	715	1 Solar T-62 @ 62 hp.	72 @ S.L.	10,300	48	
	GCA-59	YRON-1	1	0	60	20′	20′	9′	536	910	1 Porsche YO-95-6 @ 72 hp.	77 @ S.L.	7,300	112	Liaison rotorcycle.
	DSN-1,2,3	.....	0	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	Destroyer ASW drone.
Hiller Aircraft Corp. *Palo Alto, Calif.*	H-23D	Raven	1	2	581	35′ 5″	40′ 6″	9′ 9″	1,816	2,700	1 Lyc. VO-435 @ 250 hp.	95 @ S.L.	5,200	200	Army.
	12E	.....	1	2	734	35′ 5″	40′ 6″	9′ 9″	1,700	2,750	1 Lyc. VO-540 @ 305 hp.	96 @ S.L.	10,000	225	Commercial.
	E4	.....	1	3	659	35′ 5″	42′ 6″	9′ 9″	1,775	2,750	1 Lyc. VO-540 @ 305 hp.	96 @ S.L.	10,000	225	Commercial.
Hughes Tool Co., Aircraft Div. *Culver City, Calif.*	269A	.....	1	1	683	25′	28′	8′	867	1,550	1 Lyc. 0360-C2B @ 180 hp.	95 @ S.L.	6,300	220	45 min. engine change.
Kaman Aircraft Corp. *Bloomfield, Conn.*	H43A	.....	1–2	3–4	2,200	47′	47′	12′ 5″	4,330	7,850	1 P&W R1340 @ 600 hp.	119 @ 4,000′	14,200	220	Rescue; HOK-1; HUK-1.
	H43B	Huskie	1–2	11	3,100	47′	47′	12′ 7″	4,500	9,150	1 Lyc. T53 @ 860 shp.	129 @ 4,000′	25,000	250	Rescue.
	HU2K-1	SeaSprite	2	10–14	4,000	44′	52′ 2″	12′ 5″	5,052	9,052	1 GE T58-GE-6 @ 1,050 shp.	.....	.....	....	SAR/utility.
	HTK-1	.....	0	0	.....	41′	41′	12′ 3″	.....	.....	1 Lyc. O435 @ 245 hp.	.....	.....	....	Robot development.
	K-17	.....	2	0	.....	.....	37′	8′ 6″	.....	.....	1 Turboneca Turmo @ 400 eshp.	.....	.....	....	Propulsion research.
Kellett Aircraft Corp. *Willow Grove, Pa.*	KH-15	Stable Mable	1	0	.....	18′	18′	7′ 9″	244	644	2 RMI TU111 rockets @ 24 lb. t.	75 @ S.L.	.....	50	Research vehicle.
	KD-1A	.....	1	1	.....	40′	30′	10′ 9″	1,500	2,200	1 Jacobs L-4MA @ 225 hp.	110 @ S.L.	14,000	190	Autogiro.
	KD-10	.....	1	1	.....	40′	33′	9′ 11″	1,755	2,830	1 Con. IO-520 @ 260 hp.	150 @ S.L.	21,000	420	Autogiro.
McDonnell Aircraft Corp. *St. Louis, Mo.*	120	.....	1	1	.....	31′	31′	9′	2,669	6,000	3 AiResearch GTC-85-135 @ 85 hp.	120 @ S.L.	10,000	94	Flying crane.
Republic Aviation Corp. *Farmingdale, N. Y.*	.....	Alouette	1	4	1,080	33′ 6″	31′ 10″	9′	1,830	3,000	1 Turboneca Artouste C @ 480 shp.	110 @ 14,500	15,500	325	Sud Aviation license.
Sikorsky Aircraft *Stratford, Conn.*	S-55A	H-19B&D	1–2	10	2,100	53′	62′ 3″	13′ 4″	5,250	7,500	1 CW R1300-3 @ 800 hp.	112 @ S.L.	5,800	360	HRS-3; HO4S-3.
	S-55C	H-19A&C	1–2	10	1,700	53′	62′ 3″	13′ 4″	4,950	7,200	1 P&W R1340-57 @ 600 hp.	101 @ S.L.	2,000	400	HRS-102; HO4S102.
	S-56	H-37A	2–3	23	6,000	72′	88′	17′ 1″	20,831	31,000	1 P&WR2800-54 @ 2,100 hp.	130 @ S.L.	7,000	145	HR2S-1.
	S-58B	H-34A	1–2	18	4,000	56′	65′ 10″	14′ 4″	7,630	13,000	1 CW R1820-84 @ 1,525 hp.	123 @ S.L.	4,900	182	HSS-1; HUS-1.
	S-60	.....	2	.....	8,000	72′	87′ 11″	17′	19,613	31,200	1 P&W R2800-54 @ 2,100 hp.	130 @ S.L.	6,800	265	
	S-61	HSS-2	4	.....	.....	62′	72′ 5″	15′ 4″	10,854	17,300	2 GE T-58-8 @ 1,250 hp.	150 @ S.L.	9,700	305	Amphibious.
	S-61L	.....	2–3	28	6,500	62′	72′ 5″	15′ 4″	9,270	18,700	2 GE CT-110-1 @ 1,250 hp.	147 @ S.L.	7,000	285	
	S-62A	.....	1–2	9	2,000	53′	62′ 3″	14′ 2″	4,787	7,500	2 GE CT-58-100 @ 1,050 hp.	109 @ S.L.	14,000	255	
	S-64	Skycrane	3	60	14,500	72′	87′ 6″	18′ 7″	17,240	38,000	2 P&W JFTD12A @ 4,620 shp.	117 @ S.L.*	9,700	800	
Vertol Division, Boeing Airplane Co. *Morton, Pa.*	107	.....	2	22	.....	48′ 4″	81′ 8″	16′ 10″	9,100	15,500	2 Lyc. T53 @ 825 shp.	144 @ 400	.....	....	Prototype.
	107 II	.....	2	25	6,836	50′	83′ 4″	6′	9,298	18,450	GE CT58-110 @ 1,250 shp.	162 @ S.L.	7,800	280	
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2 GE CT58-110 @ 1,250 shp.	.....	.....	.....	.....
	44	.....	2	15–19	5,420	44′	86′ 4″	15′ 5″	8,980	14,300	1 Wr. R1820-103 @ 1,425 hp.	127 @ S.L.	5,400	280	
	42	H-21A	1–2	14	.....	44′	86′ 4″	16′	8,300	14,500	1 Wr. R1820-103 @ 1,150 hp.	140 @ S.L.	14,900	450	
	43	H-21B	1–2	20	.....	44′	86′ 4″	16′	8,600	15,000	1 Wr. R1820-103 @ 1,425 hp.	140 @ S.L.	6,000	400	
	43	H-21C	1–2	20	4,500	44′	86′ 4″	16′	8,600	15,000	1 Wr. R1820-103 @ 1,425 hp.	140 @ S.L.	6,100	400	
	114	HC-1B	2	33	14,864	59′ 1″	98′ 3″	18′ 6″	16,138	33,000	2 Lyc. T55-L-5 @ 2,200 shp.	176 @ S.L.	13,400	....	Chinook.

AM — Aircooled Motors
Con. — Continental
GE — General Electric
Lyc. — Lycoming
P&W — Pratt & Whitney
RMI — Reaction Motors
Wr. — Wright
* — With high drag external load



...the essence of the challenge

Today an exceptional group of scientists and engineers are pooling their specialized wisdom and genius in a race with tomorrow. These are the men of the General Motors Defense Systems Division located in Warren, Michigan and Santa Barbara, California.

ASSIGNMENT . . . Anticipate and prepare for the ultimate problem of mankind—survival . . . in peace and in war . . . survival on land, on and under the sea, in the air and to the farthest attainable reaches of outer space.

This assignment serves . . . and is served by . . . virtually every current and future field of scientific learning. It serves . . . and is served by . . . every segment of industry and government. It reaches out to a horizon as yet unknown—unexplored.

Already these men are actively at work in sea and land operations, aero-space, astrophysics, biological sciences . . . meshing their skills and ideas in America's forward movement.

Defense Systems Division will manufacture no products in volume. Rather, DSD will serve the Defense Department and other governmental agencies, in cooperation with industry and other scientific groups, in fields of fundamental research and engineering through the coordination of knowledge, abilities, ideas and hard work.

General Motors is proud to contribute, through the Defense Systems Division, to the strength of America and human progress. Top-level scientists and engineers in all of these specialized fields will find rare opportunities and challenging assignments in this fast-growing organization.

DEFENSE SYSTEMS DIVISION, GENERAL MOTORS CORPORATION, WARREN, MICHIGAN AND SANTA BARBARA, CALIFORNIA

U. S. Personal and Business Aircraft

Manufacturer and Address	Designation	No. of seats	Over-all span	Over-all length	Max. height, 3-pt.	Gross wing area, sq. ft.	Weight empty, lb.	Normal gross wt., lb.	Powerplants: Number, make, model and max. rating, ea.	Normal fuel capacity, gal.	Max. speed, mph.	Landing speed, mph.	FAA field length (takeoff), ft.	FAA field length, (landing), ft.	Max. range, mi.	Price, FAF, $
Aero Design & Eng'g. Co. Bethany, Okla.	Aero Commander 500A	7	49'+	35' 1"	14' 6"	255	4,300	6,250	2 Con. IO-4TOM @ 260 hp.	156	228	70	1,200	1,150	1,250	67,500
	Aero Commander 500B	7	49'+	35' 1"	14' 6"	255	4,325	6,750	2 Lyc. IO-540B1A5 @ 290 hp.	156	228	75	1,300	1,250	1,125	81,500
	Aero Commander 560F	7	49'+	35' 1"	14' 6"	255	4,700	7,500	2 Lyc. IGO-540B1A @ 340 hp.	223	248	85	1,350	1,300	1,544	98,500
	Aero Commander 680F	7	49'+	35' 1"	14' 6"	255	4,800	8,000	2 Lyc. IGSO-540B1A @ 380 hp.	223	255	90	1,380	1,350	1,154	113,500
Aircraft Marine Eng'g. Co. Van Nuys, Calif.	A-1 Anser	9	46'	39'	11'	260	4,100	9,000	2 Con. 420-M @ 1,200 lb. t.	480	460	43	650	650	1,650	....
	A-2 Avocet	26	72'	60'	19'	650	10,250	24,000	4 Con. 420-M @ 1,500 lb. t.	1,600	450	48	2,000	1,500	2,600	....
Bee Aviation Assoc., Inc. San Diego, Calif.	Queen Bee	4	32'	21' 10"	7' 7"	130	1,250	2,300	1 Lyc. A360 @ 150 hp.	42	160	55	950	700	650	....
	Honey Bee	1	28'	16' 10"	7' 8"	96	610	860	1 Con. A65 @ 65 hp.	8.5	120	45	700	.....	240	....
Beech Aircraft Corp. Wichita, Kansas	Super 18 (G18S)	8	49.6'	35.1'	9.6'	360.7	5,910	9,700	2 P&W R985-AN14B @ 450 hp.	318	223	84	1,980	1,850	1,536	132,300
	Queen Air (65)	7	45.8'	33.3'	14.1'	277.06	4,660	7,700	2 Lyc. IGSO-480-A1B6 @ 340 hp.	230	239	80	1,560	1,685	1,225	126,000
	Twin Bonanza (J50)	6	45.9'	31.5'	11.3'	277.06	4,470	7,300	2 Lyc. IGSO-480-A1B6 @ 340 hp.	230	235	82	1,840	1,650	1,650	100,000
	Twin Bonanza (D50E)	6	45.9'	31.5'	11.3'	277.06	4,100	6,300	2 Lyc. GO-480-G2F6 @ 295 hp.	180	214	71	1,260	1,455	1,650	87,250
	Baron (55)	5	37.8'	25.6'	9.6'	199.2	2,960	4,880	2 Con. IO-470-L @ 260 hp.	140	230	76	.....	.....	1,630	58,250
	Travel Air (B95)	5	37.8'	25.3'	9.5'	199.2	2,635	4,100	2 Lyc. O-360-A1A @ 180 hp.	112	210	70	1,280	1,590	1,410	....
	Bonanza (N35)	5	33.5'	25.1'	6.5'	181.0	1,855	3,125	1 Con. IO-470-N @ 260 hp.	78	205	60	670	400	1,215	26,500
	Debonair (A33)	4	32.8'	25.5'	8.25'	177.6	1,745	3,000	1 Con. IO-470-J @ 225 hp.	68	195	60	900	570	1,160	21,750
Call Air, Inc. Afton, Wyo.	A-5	2	35' 5"	23' 9"	7' 10"	186	1,020	2,150	1 Lyc. O-320-A2A @ 150 hp.	25	104	43	620	450	325	....
	A-6	2	35' 5"	24'	7' 10"	186	1,170	2,350	1 Lyc. O-360-A1A @ 180 hp.	40	107	46	750	450	.....	....
Cessna Aircraft Co. Wichita, Kansas	150	2	33' 4"	21' 11"	6' 11"	160	946	1,500	1 Con. O-200-A @ 100 hp.	26	124	50	1,205	1,055	630	7,495
	172	4	36'	26' 4"	8' 8"	174	1,252	2,200	1 Con. O-300C @ 145 hp.	42	140	52	1,370	1,115	790	9,795
	Skyhawk	4	36'	26' 5"	8' 8"	174	1,330	2,200	1 Con. O-300-D @ 145 hp.	42	140	52	1,370	1,115	790	11,475
	175	4	36'	26' 6"	8' 8"	174	1,325	2,350	1 Con. GO-300-C @ 175 hp.	52	147	51	1,340	1,155	755	11,995
	Skylark	4	36'	26' 6"	8' 8"	174	1,395	2,350	1 Con. GO-300C @ 175 hp.	52	149	51	1,340	1,155	760	13,775
	180	4	36'	26'	7' 6"	174	1,530	2,650	1 Con. O-470-L @ 230 hp.	65	170	56	1,080	1,330	845	15,275
	182	4	36'	27' 4"	9' 9"	174	1,550	2,650	1 Con. O-470-L @ 230 hp.	65	167	56	1,080	1,310	835	15,490
	Skylane	4	36'	27' 4"	9' 9"	174	1,632	2,650	1 Con. O-470-L @ 230 hp.	65	170	56	1,080	1,310	845	17,950
	Skywagon 185	6	36'	26' 2"	7' 6½"	174	1,520	3,200	1 Con. IO-470-F @ 260 hp.	65	176	62	1,510	1,265	885	18,950
	210	4	36' 6"	27' 9"	8' 8½"	175.5	1,735	2,900	1 Con. IO-470-E @ 260 hp.	65	199	59	1,135	1,190	1,100	23,450
	310F	5	36'	29' 7"	9' 11"	174	3,037	4,830	2 Con. IO-470-D @ 260 hp.	102	245	74	1,395	1,720	1,340	62,500
Champion Aircraft Corp. Osceola, Wis.	7 EC Traveler	2	33' 2"	21' 8"	5' 2"	170	800	1,450	1 Con. C-90-12F @ 95 hp.	29	115	38	500	350	500	....
	7FC Tri-Traveler	2	33' 2"	21' 8"	7' 2"	170	930	1,450	1 Con. C-90-12F @ 95 hp.	29	115	44	500	350	500	....
	7 GC Sky-Trac	2	33'	21' 11"	6' 2"	170	930	1,650	1 Lyc. O-290-D2B @ 140 hp.	39	135	40	300	350	660	....
	7 HC DX'er	3	33'	21' 11"	7'	164	1,000	1,650	1 Lyc. O-290-D2B @ 140 hp.	39	135	45	350	350	650	....
Downer Aircraft Ind., Inc. Alexandria, Minn.	Bellanca 260	4	34' 2"	22' 11"	6' 4"	161.5	1,690	2,700	1 Con. IO-470-F @ 260 hp.	40	208	49	390	450	880	18,990
Fletcher Aviation Corp. Rosemead, Calif.	FU-24 Utility	5	42'	31' 10"	9' 4"	294	1,890	3,500	1 Con. O-470-N @ 240 hp.	44	130	48	.....	.....	410	24,290
Forney Aircraft Fort Collins, Colo.	Fornaire F-1 (Execta, Expediter)	2	30'	20' 2"	6' 3"	143	920	1,450	1 Con. C-90-12F @ 95 hp.	24	130	56	500	600	500	....
Grumman Aircraft Engr. Corp. Bethpage, N.Y.	159 Gulfstream	14	78' 6"	64'	22' 9"	615	20,434	32,500	2 Rolls-Royce RDa. 7/2 @ 2,105 eshp.	1,304	350	94	3,860	1,900	2,500	....
	164 Ag Cat	1	35' 8"	24' 4"	10' 9"	326	2,179	3,600	1 Con. W-670 @ 220 hp.	34	110	.....	.....	.....	.....	18,500
Helio Aircraft Corp. Norwood, Mass.	H395A Courier	5	39'	30'	8' 10"	231	2,020	3,000	1 Lyc. GO-435-C2B2 @ 260 hp.	60	189	30	495	495	750	31,980
	H395 Super Courier	5	39'	30'	8' 10"	231	2,037	3,000	1 Lyc. GO-480-G1D6 @ 295 hp.	60	189	30	475	475	842	34,980
Lake Aircraft Corp. Sanford, Me.	Lake La-4	4	38'	25'	9' 4"	170	1,575	2,400	1 Lyc. O-360 @ 180 hp.	40	131	50	.....	.....	627	26,160
Lockheed Aircraft Corp. Marietta, Ga.	1329 Jet Star	10	53' 8"	60' 5"	20' 6"	543	19,095	38,888	4 P&W JT 12A-6 @ 3,000 lb. t.	2,630	565	120	5.000	4,300	2,650	....
Meyers Aircraft Co. Tecumseh, Mich.	Meyers 200B	4	30' 6"	24' 5"	8' 7"	161.5	1,960	3,000	1 Con. IO-470-D @ 260 hp.	40	206	62	.....	.....	650+	23,740
	Meyers 145T	2	30'	20' 10"	8' 2"	149	1,350	1,910	1 Con. C-145-2 @ 145	.....	166	52	.....	.....	850+	....
Mooney Aircraft, Inc. Kerrville, Tex.	Mark 21	4	35'	23'	8' 5"	167	1,490	2,450	1 Lyc. O-360 @ 180 hp.	49	190	57	.....	.....	1,130	15,995
Piper Aircraft Corp. Lock Haven, Pa.	PA-18 "150"	2	35' 3"	22' 5"	6' 7"	178.5	930	1,750	1 Lyc. O-320 @ 150 hp.	36	130	43	500	725	460	7,880
	PA-22 Caribbean	4	29' 3"	20' 6"	8' 4"	147.5	1,100	2,000	1 Lyc. O-320 @ 150 hp.	36	139	49	1,220	500	500+	8,795
	PA-22 "160" Tri-Pacer	4	29' 3"	20' 7"	8' 4"	147.5	1,110	2,000	1 Lyc. O-320-B @ 160 hp.	36	141	49	900	.....	536	9,345
	PA-23 "160" Apache	3–5	37'	27' 2"	9' 6"	204	2,230	3,500	2 Lyc. O-320-B @ 160 hp.	72	183	59	900	670	853	36,990
	PA-24 "180" Comanche	4	36'	24' 8"	7' 4"	178	1,475	2,550	1 Lyc. O-360-A1A @ 180 hp.	50	167	58	750	600	920	16,445
	PA-24 "250" Comanche	4	36'	24' 11"	7' 4"	178	1,600	2,800	1 Lyc. O-540-A1A @ 250 hp.	60	190	64	750	650	1,100	20,485
	PA-24 Pawnee	1	36' 2"	24'	6' 8"	183	1,200	2,300	1 Lyc. O-320 @ 150 hp.	40	100	57	625	400	400	9,650
	PA-23 "250" Aztec	5	37'	27' 6"	10' 3"	207	2,775	4,800	2 Lyc. O-540 @ 250 hp.	144	215	62	750	900	1,400	52,990
	PA-22 "108" Colt	2	30'	20'	6' 25"	147	940	1,650	1 Lyc. O-234-C1B @ 108 hp. @ 2600 ft.	18	120	54	950	500	324	4,995
	PA-28 Cherokee	4	30'	23' 3"	7' 3"	160	1,195	2,200	1 Lyc. O-320-B2B @ 160 hp. @ 2700 ft.	36	138	56	775	550	900	9,995
	Aztec	4	37'	27' 6"	10' 3"	207	2,950	4,800	2 Lyc. O-540-A 250 hp. @ 2575	144	215	.....	.....	.....	.....	....
Stits Aircraft Riverside, Calif.	SA9A Skycoupe	2	28' 4"	18' 4"	7' 11"	125	900	1,525	1 Con. A-200A @ 100 hp.	24	140	50	650	500	540	....
Taylorcraft, Inc. Conway, Pa.	Zephyr	4	34' 8"	24' 4"	7' 2"	179	1,700	2,750	1 Con. O-470-J @ 225 hp.	66	160	65	450	700	750	....
	Topper	1	34' 8"	24' 4"	7' 2"	179	1,635	2,750	1 Con. O-470-J @ 225 hp.	46	115	70	900	900	400	....
Transland Aircraft Torrance, Calif.	AG-2	2	42'	28' 5"	9' 8"	321.6	3,468	6,000	1 P&W R1340 @ 600 hp.	125	142	45	1,200	300	455	....
Trecker Aircraft Corp. Milwaukee, Wisc.	Trecker 166	8	46' 9"	38' 1"	16' 5"	286	5,104	8,100	2 Lyc. GSO-480-B1C6 @ 340 hp.	232.5	226	68	1,550	1,312	1,155	105,250
	Gull Amphibian (L-1)	5	44' 5"	35' 5"	12' 7"	270	4,420	6,000	2 Lyc. GO-480-B1 @ 270 hp.	190	184	72	1,380	1,410	990	74,500
	Gull Amphibian (L-2)	5	44' 5"	35' 5"	12' 7"	270	4,680	6,615	2 Lyc. GSO-480-A1A6 @ 340 hp.	190	213	72	1,440	1,800	994	89,500

Leading Foreign Gas Turbines

Manufacturer and Address	Designation	Type**	No. of compressor stages	No. of turbine stages	No. of combustors	Max. power @ S. L.	Specific fuel consumption at maximum power	Compression ratio at max. rpm.	Maximum envelope diameter, in.	Maximum envelope length, in.	Dry weight, less tailpipe, lb.	Remarks
CANADA												
Orenda Engines, Ltd. *Malton, Ont.*	Orenda 10	AFJ	10	1	6	6,355 lb. t.	1.12	5.3	42	123	2,515	
	Orenda 11	AFJ	10	2	6	7,275 lb. t.	0.99	6.1	45	121	2,425	
	Orenda 14	AFJ	10	2	6	7,275 lb. t.	0.99	6.1	45	121	2,425	
	Iroquois PS-13	AFJ	10	3	An.	20,000+ lb.t.	.....	8	47	228	4,650	
	J79-7	AFJ	17	3	10	15,000 lb. t.	.....	12	38.31	204	3,200+	CF104—built under license.
GREAT BRITAIN												
Blackburn Engines, Ltd. *Brough, E. Yorkshire*	Palouste 502*	CFJ	1C	2	A	2 lb. air/sec	1.48	3.77	17.5	33.4	215	Fuel consumption based on air hp.
	Palouste 505*	CFJ	1C	2	A	2.7 lb. air/sec.	1.26	3.81	17.5	33.4	213.5	
	Artouste 510*	CFJ	1C	2	A	2.18 lb. air/sec + 100 shp	350 lb./hr.†	3.61	17.5	37.0	235	† Actual fuel consumption.
	Artouste 510*	CFJ	1C	2	A	2.6 lb. air/sec.	320 lb./hr.†	3.53	17.5	37.0	235	† Actual fuel consumption.
	Artouste 600*	CFJ	1C	2	A	475 shp	0.98	4.0	17.5	54.0	295	Length includes cone.
	Palas 600 *	CFJ	1C	1	A	390 lb. t.	1.2	4.09	17.5	43.5	170	
	Nimbus	ACFJ	2A, 1C	2×1	A	970 shp.	0.68	6.5	28.87	61.59	390	P. 531 helicopter.
	Turmo 603*	CFJ	1C	1×1	A	425 shp.	1.105	3.86	26.4	47.9	370	
Bristol Siddeley Engines, Ltd. *Filton, England*	Double Mamba 3	AFP	10	3	A	3,145 eshp.	0.72	5.35	51.9	99	2,180	Gannet.
	Double Mamba 8	AFP	11	3	A	3,880 eshp.	0.66	5.85	56.55	103.5	2,500	Gannet.
	Viper 8	AFJ	7	1	A	1,750 lb.	1.07	4.1	24.3	67	510	Provost Mk. 3.
	Viper 9	AFJ	7	1	A	1,900 lb.	1.12	4.25	24.3	67	510	Uprated ASV 8, 326 prototype.
	Viper 11	AFJ	7	1	A	2,500 lb.	1.07	4.31	24.55	64	549	MB. 326 Macchi; Jet Provost. Mk. 304.
	Viper 12	AFJ	7	1	A	2,700 lb.	1.10	4.42	24.55	64	549	Uprated ASV. 11.
	Sapphire 6	AFJ	13	2	A	8,200 lb.	0.87	7.25	37.4	110	2,670	Javelin.
	Sapphire 7	AFJ	13	2	A	11,000 lb.	0.88	7.49	37.55	125	3,110	Javelin, Victor.
	Sapphire 7R	AFJ	13	2	A	12,230 lb.	1.38	7.49	37.55	131	3,110	Limited afterburner—Javelin.
	Proteus 705	ACFP	12A, 1C	2, 2	8	3,900 eshp.	0.62	6.93	40	100.6	2,975	Britannia 102.
	Proteus 765	ACFP	12A, 1C	2, 2	8	4,445 eshp.	0.60	7.32	40	100.6	2,960	Britannia 250, 300, 310, 320.
	Olympus 101	AFJ	6, 8	1, 1	10C	11,000 lb.	0.815	9.6	40	142.7	3,670	Vulcan B Mk. 1.
	Olympus 104	AFJ	7, 8	1, 1	10C	13,500 lb.	0.855	10.9	41.4	146.75	.....	Vulcan B Mk. 1.
	Olympus 201	AFJ	5, 7	1, 1	8C	17,000 lb.	0.835	10.7	41.6	139.3	.....	Vulcan B Mk. 2.
	Orpheus 701	AFJ	7	1	7C	4,700 lb.	1.057	4.39	32.4	83.25	795	Folland Gnat.
	Orpheus 703	AFJ	7	1	7C	4,850 lb.	1.065	4.39	32.4	91.1	835	HF-24.
	Orpheus 803	AFJ	7	1	7C	5,000 lb.	1.08	4.39	32.4	89.1	835	G. 91, Etendard VI, Taon.
	Orpheus 805	AFJ	7	1	7C	400 lb.	1.042	3.91	32.4	91.0	835	Fuji T1A Trainer.
	Orpheus 100	AFJ	7	1	7C	4,230 lb.	0.964	4.39	32.4	85.0	890	Gnat trainer.
	Orpheus 12	AFJ	8	2	7C	6,810 lb.	0.967	5.7	32.4	95.0	1,180	
	Orpheus 12 SR	AFJ	8	2	7C	8,170 lb.	1.62	5.7	32.4	95.0	1,180	Afterburner, basic thrust 6810.
	BS-75	AFJ	3, 10	2, 2	A	7,550 lb.	.508	13.0	35.5	92.3	1,525	Project
	BS-53/5	AFJ	.....	.....	.....	.....	.....	.....	.....	.....	.....	
De Havilland Engine Co. Ltd. *Leavesden, Hertfordshire*	Goblin 35	CFJ	1	1	16	3,500 lb. t.	1.16	3.7	50	110	1,630	DH Vampire trainer.
	Gyron D. Gy 2	AFJ	7	2	A	20,000 lb. t.	1.04	.....	55	156	4,270	
	Gyron Jr. D.G.J. 2	AFJ	.....	.....	.....	7,000 lb. t.	.....	.....	41	91	.....	
	Gyron Jr. D.G.J. 10	AFJ	.....	.....	.....	10,000 lb. t.	.....	.....	40	92	.....	Bristol T188 Supersonic Res. A/C.
	Gnome H. 1000	AFS	10	2, 1	1	1,050 shp.	0.65	8.3	20	55	283	GET58-6 equiv various copters.
	Gnome P. 1000	AFP	10	2, 1	1	1,000 shp.	0.69	8.3	32	76	535	Turboprop version of T58-6.
	Gnome H. 1200	AFS	10	2, 1	A. 1	1,250	0.63	8.3	20	55	308	GET58-8 equiv various copters.
	Gnome P. 1200	AFP	10	2, 1	A. 1	1,150	0.65	8.3	32	76	595	Turboprop version of H1200.
	Gnome H. 1400	AFS	10	2, 1	1	1,440 shp.	0.62	8.3	20	55	318	Uprated version of H 1200.
D. Napier & Son Ltd. *London*	Eland N. El. 1	AFP	10	3	6	3,060 eshp.	0.64	7	36	122	1,570	
	Eland N. El. 3	AFP/G	10, 9	3	6	3,000 eshp.	0.62	7	36	158	2,435	
	Eland 504	AFP	10	3	6	3,500 eshp.	0.61	7	36	115	1,820	Convair 340/440.
	Eland 508	AFP	10	3	6	1,450 shp.	0.61	7	36	115	1,820	Uprated 504.
	Eland N. El. 7	AFP/G	10, 9	3	6	3,500 eshp.	0.60	7	36	158	2,575	Uprated N. El. 3.
	Eland E. 211	AFP	10	3	6	3,710 eshp.	0.60	7	36	135	1,418	Uprated E. 229A.
	Eland E. 229A	AFP	10	3	6	3,440 eshp.	0.62	7	36	135	1,418	Twin unit for Westminster.
	Oryx N. Or. 1	AFG	12, 4	2	5	780 ghp	0.68	6	19	83	495	
	Oryx N. Or. 4	AFG	12, 4	2	5	865 ghp.	0.65	6	19	83	495	
	Oryx N. Or. 5	AFG	12, 4	2	5	950 ghp.	0.62	6.1	19	83	515	
	Gazelle N. Ga. 1	AFP	11	2+1	6	1,260 shp.	0.71	6.37	34	70	780	
	Gazelle N. Ga. 2	AFP	11	2+1	6	1,650 shp.	0.68	6.37	34	70	830	Bristol 192.
	Gazelle N. Ga. 3	AFP	11	2+1	6	1,800 shp.	0.66	6.37	34	70	865	
	Gazelle N. Ga. 4	AFP	11	2+1	6	2,000 shp.	0.635	6.37	34	70	900	
	Gazelle N. Ga. 13	AFP	11	2+1	6	.....	0.69	5.9:1	34	70	865	Wessex.
Rolls-Royce, Ltd. *Derby*	Avon RA. 24	AFJ	15	2	8	11,250 lb. t.	.....	.....	41.5	126	.....	RA. 24R with afterburner.
	Avon RA. 29	AFJ	16	3	8	10,500 lb. t.	0.77	9.1	39	126	3,308	D.H. Comet IV; Caravelle I.
	Avon RA. 29/3	AFJ	16	3	8	11,400	0.805	9.35	39	126	3,327	Caravelle 3.
	Avon RA. 29/6	AFJ	17	3	8	12,200	0.762	10.06	39	134	3,471	Caravelle 6.
	Avon RB 146	AFJ	.....	.....	8	13,220	.....	.....	.....	.....	.....	Military engine.
	Conway RCo 11	AFF	.....	.....	10	17,250 lb. t.	.....	.....	42	136	.....	
	Conway RCo 12	AFF	7+9	1+2	10	17,500 lb. t.	0.725	14.1	42	136	4,542	Boeing 707-420; DC-8.
	Conway RCo 15	AFF	7+9	1+2	10	18,500 lb. t.	0.701	14.3	42	136	4,582	DC-8.
	Conway RCo 42	AFF	.....	1+2	10	20,250 lb. t.	0.622	.....	48	150	5,001	Vickers VC-10.
	R.B. 141	AFJ	5+11	.....	10	15,000 lb. t.	0.599	16.7	42	134.5	3,613	Caravelle VII.
	R.B. 145	AFF	.....	.....	A	2,750 lb. t.	.....	.....	20.8	63.7	.....	
	R.B. 108	AFJ	.....	.....	A	2,010 lb. t.	.....	.....	20.8	42.0	.....	VTOL engine; Short S.C. 1.
	Spey R.B. 163	AFF	4+12	2+2	10	10,100 lb. t.	0.560	16.8	37	110	2,200	D.H. 121.
	Dart R. Da. 3 Mk. 506	CFP	2	2	7	1,480 eshp.	0.755	5.4	38	95	1,026	Viscount 700.
	Dart R.Da. 6 Mk. 510	CFP	2	2	7	1,675 eshp.	0.717	5.4	38	98	1,106	Viscount 700.
	Dart R.Da. 6 Mk. 511	CFP	2	2	7	1,650 eshp.	0.725	5.4	38	98	1,106	Fokker/Fairchild.
	Dart R.Da. 6 Mk. 514	CFP	2	2	7	1,650 eshp.	0.725	5.4	38	98	1,114	Avro 748.
	Dart R.Da. 7 Mk. 520	CFP	2	3	7	1,815 eshp.	0.726	5.6	38	98	1,207	Viscount 800.
	Dart R.Da. 7/1 Mk. 525	CFP	2	3	7	1,190 eshp.	0.706	5.6	38	98	1,227	Viscount 810.
	Dart RD Mk. 526	CFP	2	3	7	2,020 eshp.	0.690	5.6	38	98	1,227	A.W. Argosy.
	Dart R.Da. 7/2 Mk. 527	CFP	2	3	7	2,020 eshp.	0.690	5.6	38	98	1,227	H.P. Herald.
	Dart R.Da. 7/2 Mk. 528	CFP	2	3	7	2,030 eshp.	0.690	5.6	38	98	1,223	Fairchild F. 27.
	Dart R.Da. 7/2 Mk. 530	CFJ	2	3	7	2,020 eshp.	0.690	5.8	38	98	1,227	Viscount 833.
	Dart R.Da. 7/2 Mk. 529	CFP	2	3	7	2,100 eshp.	0.710	5.6	38	98	1,227	Grumman Gulfstream.
	Dart R.Da. 10	CFP	2	3	7	2,555 eshp.	0.663	6.35	38	98	1,376	1050 Alize.
	Dart R.Da. 7/2 Mk. 531	CFP	2	3	7	2,020	.690	5.6	38	98	1,227	Avro 748.
	Dart R.Da. 10 Mk. 542	CFP	2	3	7	3,030 eshp.	.....	6.35	38	98	1,376	Namco YS-11.
	Tyne RTy. 1	AFP	6+9	1+3	10	4,785 eshp.	0.505	13.5	43	108	2,275	Vanguard BEA.
	Tyne RTy. 11	AFP	6+9	1+3	10	5,325 eshp.	0.482	13.5	43	108	2,275	Vanguard TCA.
	Tyne RTy. 12	AFP	6+9	1+3	10	5,730 eshp.	0.449	13.5	43	108	2,177	Canadair CL-44.

Manufacturer and Address	Designation	Type**	No. of compressor stages	No. of turbine stages	No. of combustors	Max. power @ S. L.	Specific fuel consumption at maximum power	Compression ratio at max. rpm.	Maximum envelope diameter, in.	Maximum envelope length, in.	Dry weight, less tailpipe, lb.	Remarks
FRANCE												
Hispano-Suiza, *Paris*	H.S. Verdon*	350	1	1	9	7,700 lb.	1.10	4.911	4.16	8.7	2,090	Turbojet for Mystere IVA.
	H.S. Tyne*	20	9	1	10	5,665 hp.	472	.....	43.2	108.7	2,149†	Turboprop for Breguet Atlantic-N.A. Transall; †Without prop.
SNECMA, *Paris*	Atar E3	AFJ	8	1	A	7,715 lb. t.	1.05	4.8	39	162	1,851	
	Atar G2, G3	AFJ	8	1	A	9,700 lb. t.	1.85	4.8	40	253	2,720	
	Atar 08	AFJ	9	2	A	9,700 lb. t.	0.98	5.5	40	154	2,280	
	Atar 09C	AFJ	9	2	A	14,150 lb. t.	2.03	5.5	40	235	3,000	Afterburner.
	Atar 09D	AFJ	9	2	A	15,000 lb. t.	2.03	5.5	40	235	2,940	Afterburner.
Generale Aeronautique Marcel Dassault *St. Cloud*	M.D. 30 Viper	AFJ	7	1	A	1,630 lb. t.	1.10	3.8	27	66	496	Bristol-Siddeley license.
	M.D. 30R	AFJ	7	1	A	2,205 lb. t.	2.30	3.8	27	132	761	M.D. 30 with afterburner.
	R. 7	AFJ	7	1	A	3,085 lb. t.	1.07	3.8	29	79	748	
Societe Turbomeca *Paris*	Palas	CFJ	1	1	A	352 lb. t.	1.17′	3.95	16	47	158	
	Marbore II	CFJ	1	1	A	880 lb. t.	1.08′	3.85	25	62	314	
	Marbore VI	CFJ	1	1	A	1,058 lb. t.	1.08′	3.84	22	56	322	
	Gourdon	ACFJ	1	1	A	1,410 lb. t.	.99′	5.00	22	69	375	
	Gabizo	ACFJ	1	1	A	2,420 lb. t.	1.05′	5.20	26	82	585	
	Artouste II	CFP	1	2	A	400 shp.	1.07[2]	3.88	23	57	360	
	Artouste III	ACFP	1	3	A	550 shp.	.65[2]	5.20	21	58	410	
	Astazou	.....	2	3	A	420 shp.	.66[2]	5.81	18	55	297	
	Turmo III B	CFP	2	3	A	812 shp.	.67[2]	5.65	31	65	560	
	Turmo III C	CFP	2	3	A	1,100 shp.	.68[2]	5.50	.....	.....	.....	
	Palouste IV	.....	1	2	A	.....	2.60[3]	3.80	22	47	200	
	Astazou	ACFP	2	3	A	66 lb. t./469 shp.	.62[2]	5.81	18	57	320	
	Bastan	ACFP	2	3	A	14.5 lb. t./800 shp.	.65[2]	5.45	22	61	607	
	Palouste VI	.....	1	2	A	.....	3.97[3]	3.7	22	47	.....	
ITALY												
FIAT-SMA *Turin*	4002.001	CFJ	1	1	A	550 lb. t.	1.25	4	22	41	220	Helicopter.

****TYPE**

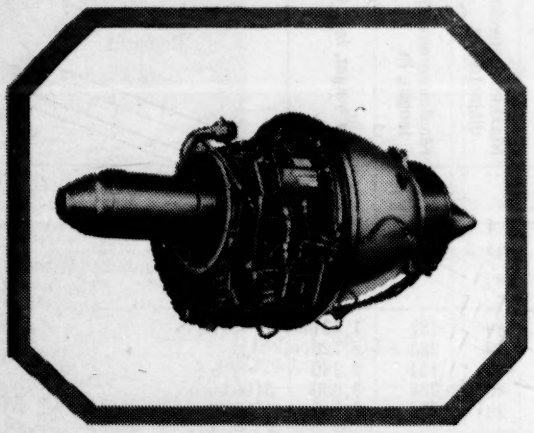
COMPRESSOR: AXIAL, CENTRIFUGAL, RADIAL — FLOW — OUTPUT: JET, PROP, FAN, SHAFT, GAS

A—Annular
Eshp—Equivalent shaft horsepower
Ghp—Gas horsepower
lb. t.—Pounds thrust
*—Built under license

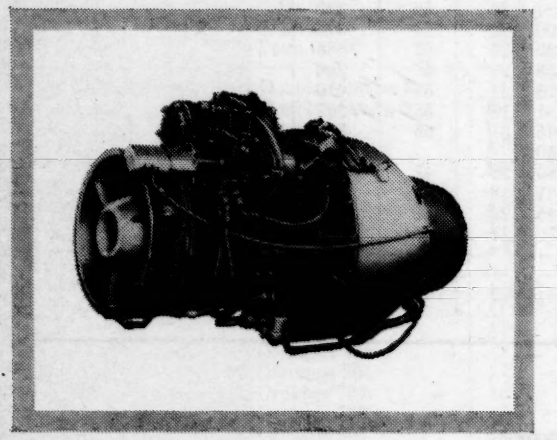
SABENA CARAVELLE

CONTINENTAL

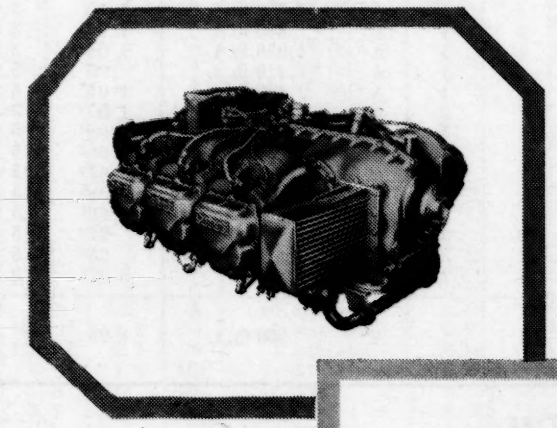
precise power is preferred power for a wide range of aerospace jobs



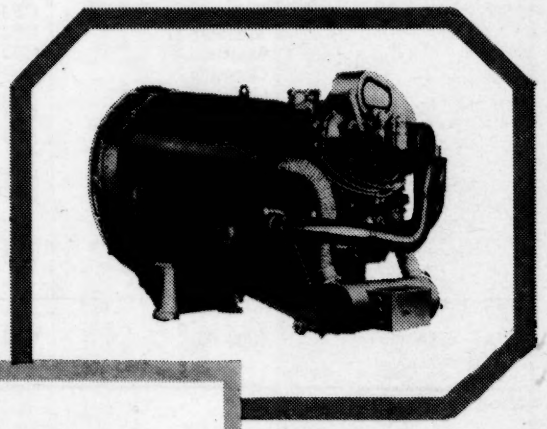
J69 Turbojet for Manned Aircraft



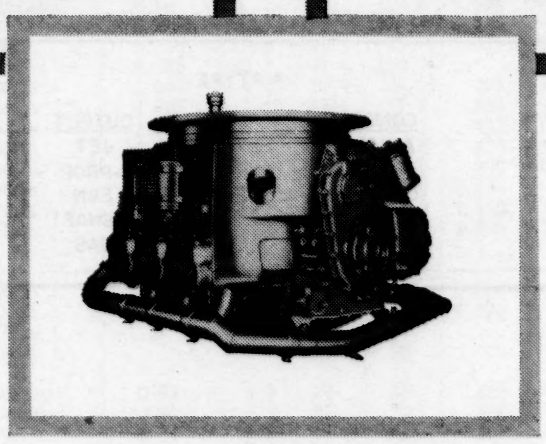
J69 Turbojet for Target Missiles



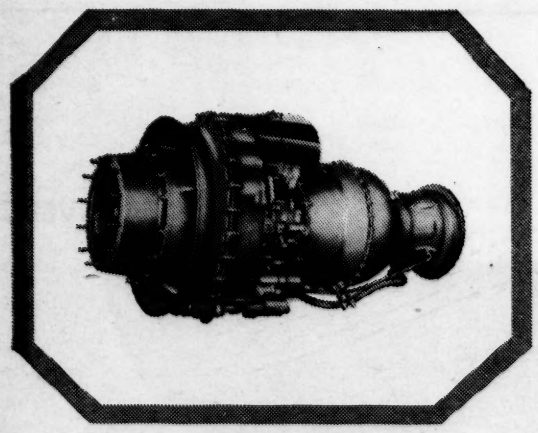
Model IO470-D Fuel Injection Engine



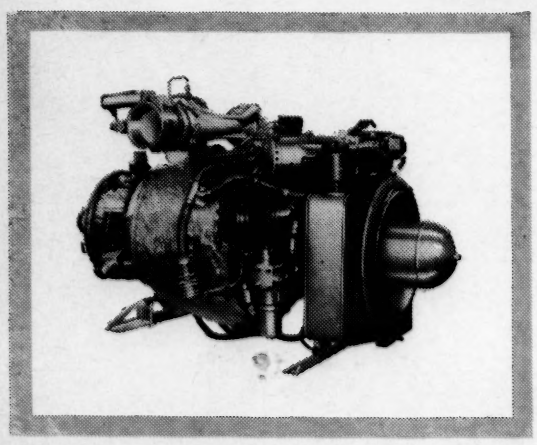
Model PE-150 Continental Packette



Model FSO526-A Helicopter Engine



T72 Turboprop-turboshaft Engine



Model 141-A Turbo-compressor

Rounding out Continental Motors' line of reciprocating engines for aircraft and ground support use, CAE offers turbines of three basic types: turbo-compressors, turboprop/turboshaft models from 400 to 1,200 hp—and turbofan/turbojets developing 1,000 to 4,000 lbs. thrust. Dependability and low cost, resulting from simplicity of design, make CAE preferred power for a widening range of applications in fixed-wing, rotary-wing and VTOL/STOL aircraft, and ground effect machines.

Both CMC and CAE are exceptionally well qualified to accept R&D assignments in the aircraft-aerospace field. Inquiries are invited.

Continental Motors Corporation

AIRCRAFT ENGINE DIVISION • MUSKEGON, MICHIGAN

CONTINENTAL AVIATION & ENGINEERING CORPORATION

12700 KERCHEVAL, DETROIT 15, MICHIGAN

SUBSIDIARY OF CONTINENTAL MOTORS CORPORATION

U.S. Reciprocating Engines

● SPECIFICATIONS

Manufacturer and Address	Designation	No. of cylinders	Cylinder arrangement	Propeller drive	Power Ratings: Max. takeoff power (hp.)—SL	Power Ratings: At rpm.	Power Ratings: Normal rated power (hp.)	Power Ratings: At rpm	Power Ratings: At altitude (ft.)	Fuel grade	Diameter or dimensions in. (without cowling)	Blower ratio	Gross weight dry (lb.)
Aircooled Motors, Inc. *Syracuse, N. Y.*	4A4-100-B3	4	Ho	Direct	100	2,550				80			200
	6A4-150-B3	6	Ho	Direct	150	2,600				80			278
	6A4-165-B3	6	Ho	Direct	165	2,800				80			278
	6AG4-185-B12	6	Ho	G. 632:1	185	3,100				80			232
	6A4-200-C6	6	Ho	Direct	200	3,100				91			307
	6V4-200-C32[1] C33, O335-5, -6	6	Vo	Direct	200	3,100				91			297
	6V6-245-B 16F[1] O425-1	6	Vo	Direct	245	3,275				80			372
	6V-335-A, -B	6	Vo	Direct	210	3,100				91			295
	6VS-335	6	Ho	Direct									
Avco Manufacturing Corp. **Lycoming Division** *Stratford, Conn.*	O-235-C1B	4	Ho	Direct	115	2,800	108	2,600	SL	80	22.53x32		240
	O-290-D2C	4	Ho	Direct	140	2,800	135	2,600	SL	80/87	22.81x32.24		264
	O-320-A2C	4	Ho	Direct	150	2,700	150	2,700	SL	80/87	23.12x32.24		271
	O-320-B2C	4	Ho	Direct	160	2,700	160	2,700	SL	91/96	23.12x32.24		277
	O-320-B3C	4	Ho	Direct	160	2,700	160	2,700	SL	91/96	23.12x32.24		277
	O-340-A1B	4	Ho	Direct	170	2,700	170	2,700	SL	91/96	24.55x32.55		278
	O-360-A1D	4	Ho	Direct	180	2,700	180	2,700	SL	91/96	24.72x33.37		284
	O-360-A1C	4	Ho	Direct	180	2,700	180	2,700	SL	91/96	24.59x33.37		288
	O-360-C2D	4	Ho	Direct	180	2,700	180	2,700	SL	91/96	19.68x33.37		288
	O-540-F1B5(3)	6	Ho	Direct	260	2,575	235	2,800	SL	91/96	24.56x33.37		398
	O-540-A1D5	6	Ho	Direct	250	2,900	250	2,575	SL	91/96			397
	VO-360-A1B	6	Vo	Direct	180	3,400	180	2,900	SL	91/96	21.92x33.37		298
	VO-435-A1E	6	Vo	Direct	260	3,200	250	3,200	SL	80/87	34.73x33.58		391
	VO-540-B1B	6	Vo	Direct	305	3,200	305	3,200	SL	80/87	24.57x34.14		429
	VO-540-B1C	6	Vo	Direct	305	3,200	305	3,200	SL	80/87	24.57x34.14		430
	VO-540-B1D	6	Vo	Direct	305	3,200	305	3,200	1000	80/87			437
	GO-435-C2B2-6	6	Ho	Gear	260	3,400	245	3,100	SL	80/87	28.02x33.12		430
	GO-480-B1E-6	6	Ho	Gear	270	3,400	260	3,000	SL	80/87	28.02x33.12		432
	GO-480-B1D	6	Ho	Gear	270	3,400	260	3,000	SL	80/87	28.02x33.12		432
	GO-480-G1G6	6	Ho	Gear	295	3,400	280	3,400	SL	100/130	28.02x33.12		439
	GO-480-G1F6	6	Ho	Gear	295	3,400	280	3,000	SL	100/130	27.46x33.12		437
	GO-480-G2F6	6	Ho	Gear	295	3,400	280	3,000	SL	100/130	28.02x33.12		442
	GSO-480-B1B6	6	Ho	Gear	340	3,400	320	3,200	8,000	100/130	33.26x33.12		500
	GSO-480-B1C6	6	Ho	Gear	340	3,400	320	3,200	8,000	100/130	22.56x33.12		497
	GSO-480-B2D6	6	Ho	Gear	340	3,400	320	3,200	8,000	100/130	22.56x33.12		498
	IO-360-B1A	6	Ho	Direct	180	2,700	180	2,700	SL	91/96			291
	IO-540-A1A	6	Ho	Direct	290	2,575	290	2,575	SL	100/130			441
	IO-540-B1A5	6	Ho	Direct	290	2,575	290	2,575	SL	100/130			437
	IGO-540-A1A	6	Ho	Gear	350	3,400	325	3,000	SL	100/130			510
	IGO-540-B1A	6	Ho	Gear	350	3,400	325	3,000	SL	100/130			504
	IGSO-480-A1B6	6	Ho	Gear	340	3,400	320	3,200	11,000	100/130	23.29x33.12		497
	IGSO-540-A1A	6	Ho	Gear	380	3,400	360	3,200	11,500	100/130			538
	IGSO-540-B1A	6	Ho	Gear	380	3,400	360	3,200	11,500	100/130			532
	IMO-360-B1B	4	Ho	Direct	225	3,400	225	3,400	SL	100/130	17.47x33.37		274
Continental Motors Corp. *Muskegon, Mich.*	A-65-BF	4	Ho	Direct	65	2,300	.....	.....	.....	80/87			170
	C-85-12F	4	Ho	Direct	85	2,575	.....	.....	.....	80/87			184
	C-90-12F	4	Ho	Direct	90	2,475	.....	.....	.....	80/87			188
	E-185-9	6	Ho	Direct	205	2,600	.....	.....	.....	80/87			352
	E-225-4	6	Ho	Direct	225	2,650	.....	.....	.....	80/87			355
	O-200-A	4	Ho	Direct	100	2,750	.....	.....	.....	80/87			190
	O-300-A,-B,-C,-D	6	Ho	Direct	145	2,700	.....	.....	.....	80/87			268
	O-470-4	6	Ho	Direct	225	2,600	.....	.....	.....	91/96			415
	O-470-15	6	Ho	Direct	213	2,600	.....	.....	.....	80/87			405
	O-470-J	6	Ho	Direct	225	2,550	.....	.....	.....	80/87			378
	O-470-K,-L	6	Ho	Direct	230	2,600	.....	.....	.....	80/87			404
	O-470-G,-M-H[2]	6	Ho	Direct	240	2,600	.....	.....	.....	91/96			410
	GO-300-A,-B,-C,-D	6	Ho	.750:1	175	3,200	.....	.....	.....	80/87			314
	IO-470-J,-K	6	Ho	Direct	225	2,600	.....	.....	.....	80/87			309
	IO-470-C,-G,-P[2]-R	6	Ho	Direct	250	2,600	.....	.....	.....	91/96			432
	IO-470-D,-E,-F,-H,-L,-M,-N	6	Ho	Direct	260	2,625	.....	.....	.....	100/130			426
	FSO-526-A[2]	6	Ho	Direct	270	3,200	270	3,200	7,900	91/96		10.04	553
	TSIO-470-B	6	Ho	Direct	260	2,600	260	2,600	16,000	100/130		2.20	427[3]
Pratt & Whitney Aircraft Div. **United Aircraft Corp.** *East Hartford, Conn.*	R2000-D5	14	Rad	G .500	1,450	2,700	1,200	2,550	6,400	100/130	49.10	7.15	1,585
	R2000 2SD13-G	14	Rad	G .500	1,450	2,700	1,200	2,550	5,000	100/130	49.10	7.1549.52	1,605
	R2800-CB3	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	100/130	52.80	7.29	2,357
	R2800-CB4	18	Rad	G .450:1	2,500	2,800	1,800	2,600	8,500	108/135	52.80	7.29	2,357
	R2800-CB16	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	100/130	52.80	7.29+8.58	2,390
	R2800-CB17	18	Rad	G .450:1	2,500	2,800	1,800	2,600	8,500	108/135	52.80	7.29+8.58	2,390
	R2800-CB2	18	Rad	G .450:1	2,500	2,800	1,900	2,600	7,000	115/145	52.8	7.29	2,370
	R2800-CB5,-54	18	Rad	Direct	2,100	2,700	1,900	2,600	7,000	115/145	52.8	7.29	2,330
	R2800-CB15,-99W	18	Rad	G .450:1	2,500	2,800	1,900	2,600	7,000	115/145	52.8	7.29+8.58	2,403
Wright Aeronautical **Curtiss-Wright Corp.** *Wood-Ridge, N. J.*	749C18BD1 R3350-75	18	Rad	G .4375:1	2,250	2,800	2,100	2,400	4,400	100/130	55.92	6.46	2,915
	826C9HD345 R1820-76A-76B	9	Rad	G .666:1	1,425	2,700	1,275	2,500	3,000	100/130	55.27	7.21	1,380
	836C18CA2 R3850-26WB	18	Rad	G .4375:1	2,700	2,900	2,300	2,600	6,200	115/145	55. 6	6.46	2,953
	853C7BA1 R1300-1A	7	Rad	G .5625:1	800	2,600	700	2,400	5,000	91/98	50.45	7.21	1,065
	856TC18DB1,2,3	18	Rad	G .4375:1	3,500	2,900	2,600	2,600	6,600	115/145	56. 6	6.46	3,520
	863C9HD1 R1820-103	9	Rad	Direct	1,425	2,700	1,275	2,500	3,000	100/130	54.95	7.21	1,380
	865C7BA1 R1300-2B	7	Rad	Direct	800	2,600	700	2,400	5,000	91/98	50.45	7.21	1,067
	867C9HE1,2 R1820-82-82A	9	Rad	G .5625:1	1,525	2,800	1,275	2,500	3,500	115/145	55.74	7.21	1,469
	871C7BA1 R1300-3	7	Rad	Direct	800	2,600	700	2,400	5,000	91/98	50.45	7.21	1,080
	872TC18DA1 R3350-34	18	Rad	G .4375:1	3,250	2,900	2,600	2,600	6,500	115/145	56. 6	6.46	3,641
	878TC18EA1,2 R3350-32W-32WA	18	Rad	G .4375:1	3,700	2,900	2,800	2,600	4,100	115/145	56. 6	6.46	3,560
	895C9HE1,2,3 R1820-84,84A,84B	9	Rad	Direct	1,525	2,800	1,275	2,500	3,500	115/145	55.74	7.21	1,419
	896C9HD1 R1820-86	9	Rad	G .666:1	1,425	2,700	1,275	2,500	3,100	100/130	55.27	7.21	1,385
	923TC18DA1 R3350-91	18	Rad	G .4375:1	3,250	2,900	2,600	2,600	6,500	115/145	56. 6	6.46	3,782
	932TC18EA1 R3350-38	18	Rad	G .355:1	3,400	2,900	2,860	2,650	4,860	115/145	56. 6	6.46	3,782
	957C7BA1	7	Rad	G .5625:1	800	2,600	700	2,400	7,300	91/98	50.45	7.21	1,065
	968C9HE1,2	9	Rad	G .5625:1	1,475	2,800	1,275	2,500	3,500	100/130	54.95	7.21	1,390
	972TC18DA1,2	18	Rad	G .4375:1	3,250	2,900	2,600	2,600	6,500	115/145	56. 6	6.46	3,581
	975C18CB1	18	Rad	G .4375:1	2,800	2,900	2,400	2,600	4,300	115/145	56. 6	6.46	3,065
	988TC18EA1	9	Rad	G .666:1	1,425	2,700	1,275	2,500	3,300	100/130	54.95	6.46	1,371
	988TC18EA2	18	Rad	G .4375:1	3,400	2,900	2,800	2,600	4,700	115 145	56.59	6.46	3,645
	941C9HE1 R1820-82WA	9	Rad	Direct	1,525	2,800	1,275	2,500	3,500	115/145	55.74	7.21	1,398
	918C9HE1 R1820-88	9	Rad	G .5625:1	1,625	2,800	1,275	2,500	3,500	115/145	55.74	7.21	1,484
	R1820-90-9A	9	Rad	G .355:1	1,525	2,800	1,275	2,500	3,500	115/145	55.74	7.21	1,620
	981TC18EA1 R3350-42	9	Rad	Direct	1,525	2,800	1,275	2,500	3,500	115/145	55.74	7.21	1,422
	981TC18EA1	18	Rad	G .4375:1	3,400	2,900	2,600	2,600	6,500	115/145	56.59	.....	3,730
		9	Rad	Direct	1,525	2,800	1,275	2,500	3,500	115/145	55.75	7.21	1,401

G—Geared
Ho—Horizontally opposed.
Rad—Radial.

SL—Sea level.
Vo—Vertically opposed.
[1] For helicopter installation.

[2] Extended propeller shaft.
[3] Engine has a 42 pound turbo-charger that is mounted separate.

They're ready for the T-38

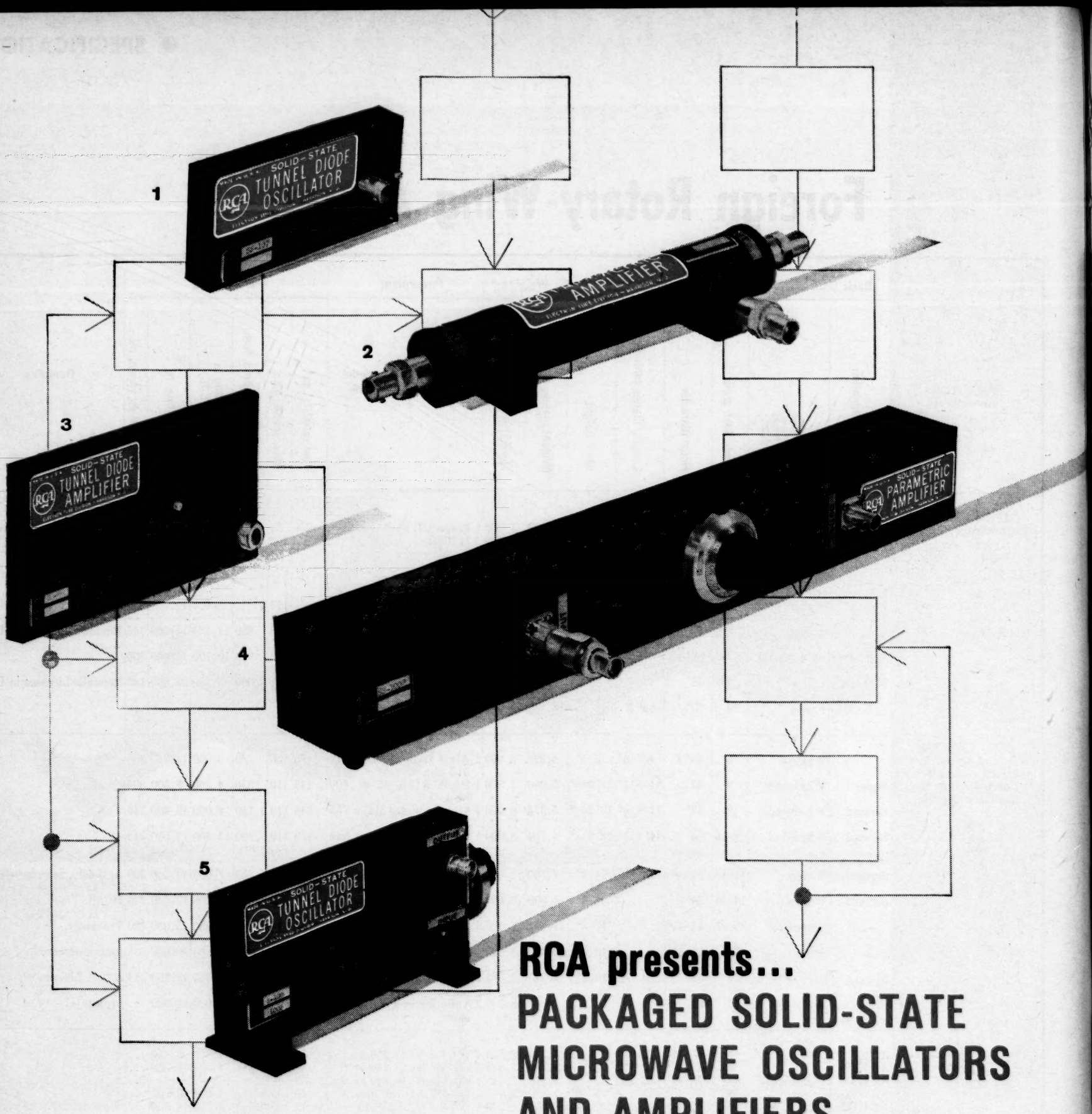
The first T-38 Talons will arrive at Randolph Air Force Base this month. These new supersonic twin-jet trainers, designed by Northrop for USAF, combine high performance with maximum pilot safety and aerodynamic stability. Before long every USAF pilot who learns to fly today's military aircraft will be trained in the supersonic safety of the T-38.

NORTHROP

Northrop Corporation, Beverly Hills, California

Foreign Rotary-Wing Aircraft

Manufacturer and Address	Basic Data: Model designation	Name	Seats, incl. crew	Dimensions: Rotor diameter	Length, blades folded	Max. height	Weights: Weight empty, lb.	Normal gross weight, lb.	Powerplant: Number, make, model and max. rating, ea.	Performance: Fuel capacity, gal.	Max. speed, mph.	Initial rate of climb, fpm.	Hovering ceiling in ground effect, ft.	Service ceiling, ft.	Max. still air range, mi.	Remarks
CZECHOSLOVAKIA																
Czechoslovak Aircraft Works *Prague*	HC-2	Heli-Baby	2	28′ 10″	34′ 4″	8′ 4″	838	1,280	1 Praga DH @ 83 hp.	8.8	81	705	3,940	9,940	93	Produced in Otrokovice.
	HC-3	.....	5	38′ 0″	.....	10′ 9″	.....	3,086	1 M108H	.....	100	.....	.....	.....	...	
FRANCE																
Helicop-Air *Paris*	L 50	Girhel	2	32′	.....	.....	.....	.....	1 Con. C 90 @ 90 hp.	.....	...	.....	.....	.....	...	
	L 51	Girhel	2	32′ 9″	.....	8′ 10″	915	1,650	1 Lyc. 0-320 @ 150 hp.	.....	112	.....	.....	.....	620	
Sud Aviation *Paris*	S. E. 3130	Alouette II	5	33′ 6″	31′ 6″	9′	1,874	3,300	1 Turbomeca Artouste II @ 400 eshp.	152	106	880	11,150	14,800	346	Republic Licensee in U. S.
	S. E. 3160	Alouette III	7	36′ 1″	33′ 6″	9′ 8″	2,359	4,630	1 Turbomeca Artouste III @ 870 hp.	157	118	900	10,700	14,000	300	
	S. O. 1221	Djinn	2	36′	17′ 6″	8′	790	1,676	1 Turbomeca Palouste IV @ 528 eshp., tip jet	.....	81	6,000	3,280	27,860	140	Republic Licensee in U. S.
	S. E. 3210	Frelon	29	62′	55′ 9″	16′ 3″	13,230	29,476	3 Turbomeca Turmo III C @ 1320 hp.	.....	...	.....	.....	.....	...	
GREAT BRITAIN																
Westland Aircraft Ltd. **Bristol Helicopter Div.** **Fairey Aviation Div.** **Saunders Roe Div.** *Yeovil*	.....	Widgeon	5	49′ 2″	40′ 10″	13′ 4″	4,322	5,900	1 Alvis Leonides 521/2 @ 515 bhp.	83	110	770	6,000	11,800	300	
	Series 1	Whirlwind	8	53′	41′ 8½″	13′ 2½″	5,090	7,500	1 P&W R1340/40 @ 600 bhp.	145	110	530	4,700	7,500	294	
	Series 2	Whirlwind	8	53′	41′ 8½″	13′ 2½″	5,375	8,000	1 Alvis Leonides Major 755 @ 780 bhp.	145	110	1,150	8,000	13,600	336	
	Series 3	Whirlwind	8–10	53′	41′ 8½″	13′ 2½″	4,700	8,000	1 de Havilland Gnome free Turbine H. 1000 @ 1050 shp.	179	110	1,200	14,500	16,500	316	
	Series 1	Wessex	14–18	56′	.....	14′ 3″	7,600	12,600	1 Nap. Gaz, N. Ga. 13 free Turbine @ 1450 shp.	265	132	1,750	7,000	14,200	390	Anti-sub., Search-strike.
	Series 2	Wessex	14–18	56′	.....	14′ 3″	7,800	13,500	2 de Havilland Gnome free Turbine H.1200 @ 1250	308	132	1,500	16,500	17,500	345	Hi-Alt. Troop. Freight Tr.
	.....	Belvedere	20–27	48′ 11″	.....	17′ 3″	11,121	19,000	2 Nap. Gaz, N. Ga 2 @ 1650 shp.	532	138	1,000	9,850	13,000	420	Transport.
	.....	Scout	5–6	32′ 3″	.....	10′ 4″	4,340	5,000	1 Blackburn A 129 Mk 3 @ 968 shp.	160	127	1,490	17,800	20,000	288	Liaison-Recon.
	Mk. 12	Skeeter	1	32′	.....	10′ 2″	1,875	2,350	1 de Havilland Gipsy Major 215 @ 215 bhp.	23	122	1,150	5,500	12,800	214	A.O.P. Liaison.
	.....	Rotodyne	62	104′	.....	23′ 2″	.....	58,500	2 Rolls Royce Tyne @5250 shp.	1,250	202	.....	9,000	10,000	...	Prototype.
ITALY																
G. Agusta	AB47J	.....	4	37. 17′	42. 82′	12′	1,780	2,563	1 VO-435-A1 @ 260 hp.	50	105	811	4,300	8,150	...	
Soc. Costruz. Aeron. *Cascina Costa (Gallarate) Varese*	AB47J2	.....	5	37. 17′	42. 13′	12′	1,790	2,845	1 VO-540-B1 @ 240 hp.	50	105	515	4,300	9,300	...	
	AB47J3	.....	5	37. 17′	42. 13′	12′	1,815	2,948	1 VO-540-B1 @ 240 hp.	50	...	.....	.....	.....	...	
	AB47G2	.....	3	35. 13′	42. ′	11. 89′	1,580	2,442	1 VO-435-A1B @ 260 hp.	40	100	811	5,600	10,795	...	
	AB47G3	.....	3	37. 17′	33. 21′	9. 29′	1,600	2,645	1 AM 6 VS-335 @ 220 hp.	40	105	743	9,700	14,600	...	Supercharger.
	AB102	.....	8	47. 50′	54. 85′	10. 63′	4,075	6,215	1 P&W R-1340 @ 600 hp.	100	110	871	.....	8,200	...	
	A204	.....	10	44′	38. 39′	12. 37′	4,200	7,986	1 D.H. Gnome H-1000 @ 1050 hp.	.....	...	.....	.....	.....	...	
	A104	.....	2	26. 08′	20. 83′	7. 71′	836	1,408	1 MV-A-120 @ 140 hp.	.....	102	792	3,000	9,840	...	
Aer Lauldi *Udine*	L. 59	.....	2	35. 12′	40. 91′	9. 84′	1,700	2,684	1 Con. 1C-470-D @ 250 hp.	40	100	792	5,575	8,530	...	
Fiat Aviation Division *Turin*	7002	.....	7	39′ 5″	.....	9′ 5″	1,320	3,085	1 Fiat 4700 Gas Generator @ 530 hp.	.....	106	.....	.....	11,150	185	Two-blade rotor
Manzollni DiCampoleone *Rome*	.....	Libellula	1	29. 8′	34. 53′	9. 84′	980	1,430	1 Walter 4-III @ 105 hp.	10	65	630	4,000	7,500	160	
NETHERLANDS																
Nederlandse Helicopter Industrie N.V. *Papendrecht*	H-3	Kolibrie	2	33′	33′	9′	600	1,540	2 NHI TJ-5A ramjet @ 62 hp.	106	70	740	9,600	11,000	45	Agriculture.
POLAND																
Aircraft Construction Center *Swidnik*	SM-2	.....	5	47′	55′ 7½″	10′ 10″	4,000	5,380	1 Al-26V @ 575 hp.	.....	99	886	6,562	13,120	217	Polish version of Mil Mi-1.
	BZ-4	Zuk	4	39′ 4½″	41′ 10″	8′ 6½″	2,315	3,300	1 Narkiewicz WN @ 320 hp.	44	97	905	1,970	9,840	161	
WEST GERMANY																
Carl F.W. Borgward *Bremen*	.....	Kolibri I	3	30′ 10″	27′ 3″	10′	1,765	2,645	1 Lyc. VO-435-A1B @ 260 hp.	40	100	790	492	14,760	250	
Bolkow-Entwicklungen *Ottobrunn Bei Munchen*	.....	Bo-103	1	21′ 7″	.....	.....	.....	882	1 ILO @ 40-50 hp.	.....	87	.....	.....	.....	280	Trainer.



RCA presents...
PACKAGED SOLID-STATE MICROWAVE OSCILLATORS AND AMPLIFIERS

Now, RCA takes a major step ahead in microwave technology—to integrate packaged microwave circuits with RCA developed solid-state diodes and provide an important, new line of components for the needs of microwave designers. Low power requirements, and compact packaging using RCA Semiconductor and Materials Division's latest tunnel and varactor diodes open new possibilities for miniaturization, improved systems reliability, and systems cost reduction. Here are the first members of a growing family of packaged microwave circuits.

In addition to the performance characteristics of the packaged circuits shown here, RCA Solid-State Microwave Oscillators and Amplifiers can be designed to meet your special requirements for gain, power, frequency, and noise characteristics. For delivery quotations and technical data on circuits to meet your needs, contact the RCA Field Office nearest you. Or write: Microwave Marketing, RCA Electron Tube Div., Harrison, N. J.

1. **Fixed-Tuned Tunnel-Diode Oscillator** (Dev. No. SS-107) Delivers a minimum power output of 1 milliwatt at your specified frequency between 500-2000 Mc. DC input; 160 ma at 0.40 volt.
2. **Helix Parametric Amplifier** (Dev. No. SS-1000) Stable minimum gain of 15 db from 2200-2300 Mc with a 5-7.5 db noise factor. Typical saturated power output of 1 milliwatt; with 300 milliwatts pump power at 3000 Mc.
3. **Tunnel-Diode Amplifier** (Dev. No. SS-500) Stable minimum gain of 15 db from 1275-1325 Mc with 6 db max. noise factor, including typical circulator loss. Saturated power output of 30 microwatts. DC input; 10 ma at 0.1 volt.
4. **Tunable Low-Noise Parametric Amplifier** (Dev. No. SS-1002) Tunable with 5 Mc bandwidth from 1250-1350 Mc, with stable minimum gain of 15 db. Max. noise factor, 3 db. Saturated power output of 0.5 milliwatt, with 60 milliwatts pump power at 10,800 Mc.
5. **Tunable Tunnel-Diode Oscillator** (Dev. No. SS-100) Delivers a minimum power output of 0.3 milliwatt from 1050-1400 Mc. Coax. output. DC input; 30 ma at 0.2 volt.

RCA Electron Tube Division Field Offices

INDUSTRIAL PRODUCTS SALES

Detroit 2, Michigan, 714 New Center Building, TR 5-5600 • Newark 2, N. J., 744 Broad St., HU 5-3900 • Chicago 54, Illinois, Suite 1154, Merchandise Mart Plaza, WH 4-2900 • Los Angeles, California, 6801 East Washington Boulevard, RA 3-8361 • Burlingame, California, 1838 El Camino Real, Ox 7-1620.

GOVERNMENT SALES

Harrison, N. J., 415 South 5th St., HU 5-3900 • Dayton 2, Ohio, 224 North Wilkinson St., BA 6-2366 • Washington 7, D. C., 1725 "K" St., N.W., FE 7-8500.

The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

See the RCA exhibit at the IRE Show, Booths 1602-1608 and 1701-1707.

Circle Number 204 on Reader-Service Card

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Max. height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
Hurel-Dubois *Route de Verrieres a Meudon, Villacoublay; (Seine-et-Oise)*	H.D. 321	.....	Transport	3	40	148′ 7½″	77′ 4″	28′ 7½″	1,076	24,498	41,200	2 Wright 982C9HE1 @ 1,525 hp.	206
	H.D. 34	.....	Photo	7	0	148′ 7½″	77′ 6″	28′ 7½″	1,076	26,300	42,600	2 Wright 982C9HE2 @ 1,475 hp.	206
Societe des Avions Max Holste *11 Rue Gosset, Reims*	MH-1521	Broussard	Utility aircraft	1	6–8	45′ 1″	28′ 3″	12′	273.4	3,373	5,925	1 P&W R985 @ 444 bhp.	165
	MH-260	Super Broussard	Light transport	1–2	20–23	71′ 11″	57′ 8″	20.9	586.5	9,735	16,975	2 Bastan III Turbomeca @ 986 eshp.	280
	MH-270	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	P-182 Turboprop.	.....
	MH-280	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	Lyc. T-53 Turboprop.	.....
Morane-Saulnier *3 & 5 Rue Volta Puteaux (Seine)*	MS-733	Aleyon	Trainer	3	0	37′	31′ 1″	11′ 4″	235	2,810	3,850	1 Potez 6 DO2A @ 240 hp.	164
	MS-760	Paris	Business	1	3	33′ 3″	32′ 11″	8′ 7″	194	4,400	7,600	2 Turb. Marbore II @ 880 lb. t.	405
	MS-1500	Epervier	Attack	2	0	42′	34′ 8″	10′ 9″	259	3,650	6,270	1 Turb. Bastan @ 870 eshp.	250
	MS-880	Rallye	Personal	1	2	28′ 8″	20′ 5″	8′ 6″	112	950	1,570	1 Con. C14F @ 95 hp.	128
Nord Aviation, Societe Nationale de Constructions Aeronautiques *12 bis Avenue Bosquet, Paris (7)*	Nord 2502	Noratlas	Transport	3	40	110′ 3″	72′	.....	1,089	28,085	50,700	2 Bristol Hercules 785/759 @ 2040 bhp. +2 Turbomeca Marbore II @ 880 lb. t.	.....
	Nord 2508	Noratlas	Transport	3	40	110′ 3″	72′	.....	1,089	29,080	50,700	2 P&W R2800 @ 2500 bhp.+2 Turbomeca Marbore II @ 880 lb. t.	270
	Nord 2501	Noratlas	Transport	3	42	107′	72′	10′ 1″	1,083	28,600	48,400	2 SNECMA Hercules @ 2,040 hp.	275
	Nord 3202	.....	Trainee	2	0	32′ 1½″	26′ 2½″	10′ 3″	177.5	1,813	2,495	1 Potez 4.D-32 @ 240 hp.	161
	Nord 1405	Gertaut II	Fighter	1	0	24′ 7″	32′ 6″	13′ 6″	282	8,058	10,252	1 SNECMA Atar 101G @ 9,700 lb. t.	M1.3
	Nord 1500	Griffon II	Interceptor	1	0	26′ 7″	47′ 8½″	16′ 5″	344.5	.....	14,550	1 SNECMA Atar 101E3+1 Nord ramjet.	930
	Nord 3409	.....	Liaison	1	1	41′ 8″	27′ 8″	10′ 2″	209.9	2,028	2,976	1 Potez 4. D-30 @ 240 hp.	124*
Potez Air-Fouga *90 Rue Miromesnil, Paris (8)*	C.M. 170	Magister	Trainer	2	.....	37′	33′	9′	186	4,268	6,978	2 Potez Air Fouga Type C.M. 170 @ 880 lb. t.	435
	C.M. 175	Zephyr	Carrier, Trainer	2	.....	37′	33′ 7″	9′	186	4,706	7,417	2 Potez Air Fouga Type C.M. 175 @ 880 lb. t.	403
	Potez 75	.....	Attack	2	0	43′	30′	8′ 10″	.....	5,891	5,578	1 Potez 8. D-32 @ 520 hp.	171
	P. 840	.....	Transport	...	16–24	63′	50′	.....	.....	8,910	16,720	4 Turbomeca Astazou.	300
Sud Aviation *37, Boulevard de Montmorency, Paris (XVIe)*	S.E. 210	Caravelle	Transport	3–4	80	112′ 6″	104′ 10″	28′ 6″	1,579	57,970	99,210	2 R-R Avon Mk. 527 @ 11,700 lb. t.	510
	S.E. 210-I	Caravelle I	Transport	2–3	80	112′ 6″	105′	28′ 7″	1,579	58,422	95,901	2 R-R Avon 522 @ 10,500	465
	S.E. 210-III	Caravelle III	Transport	2–3	80	112′ 6″	105′	28′ 7″	1,579	59,525	101,413	2 R-R Avon 527 @ 11,400	498
	S.E. 210-VI	Caravelle VI	Transport	2–3	80	112′ 6″	105′	28′ 7″	1,579	61,222	105,822	2 R-R Avon 531 @ 12,200	528
	S.E. 210-VIR	Caravelle VIR	Transport	2–3	80	112′ 6″	105′	28′ 7″	1,579	63,206	40,232	2 R-R Avon 533R @ 12,600	525
	.....	Caravelle VII	Transport	2–3	80	112′ 6″	105′	28′ 7″	1,579	63,206	40,232	2 CJ-805-23 @ 16,100	540
GREAT BRITAIN													
Sir W. G. Armstrong Whitworth Aircraft, Ltd. *Baginton, Nr. Coventry, Warwickshire*	AW 650	Argosy	Freighter	2–3	89	115′	86′ 9″	27′	1,458	47,421	88,000	4 R-R Dart @ 2,100 eshp.	296
	AW 660	Argosy	Freighter	4	77	115′	86′ 9″	27′	1,458	56,000	97,000	4 R-R Dart @ 2,670 eshp.	926
	AW 670	Argosy	Air Ferry	2–3	126	115′	88′	27′	1,458	52,500	88,000	4 R-R Dart @ 2,100 eshp.	265
	F.(G.A.) Mk.6	Sea Hawk	Fighter Bomber	1	0	39′	39′ 8″	8′ 8″	278	13,200	16,200	1 R-R Nene 103	524
Blackburn Aircraft Ltd. *Brough, Yorkshire*	C. Mk. 1	Beverley	Transport	4	97	162′	99′ 5″	38′ 5″	2,916	82,100	145,000	4 Bristol Centaurus @ 2,850	238
	NA 39	Buccaneer	Strike	2	.....	42′ 6″	62′ 4″	16′ 0″	.....	.....	.....	2 De Havilland Gyron Junior	.....
Bristol Aircraft, Ltd. *Filton House, Bristo*	175	Britannia 100	Transport	9	92	142′ 4″	114′	37′ 6″	2,075	88,000	155,000	4 B-S Proteus 705 @ 3,900 eshp.	370
	175	Britannia 300	Transport	9	132	142′ 4″	124′ 3″	37′ 6″	2,075	92,850	160,000	4 B-S Proteus 755 @ 4,120 eshp.	400
	175	Britannia 310	Transport	9	132	142′ 4″	124′ 3″	37′ 6″	2,075	93,400	185,000	4 B-S Proteus 765 @ 4,445 eshp.	410
	175	Britannia 250	Pass./Cargo	9	84	142′ 4″	124′ 3″	37′ 6″	2,075	95,900	185,000	4 B-S Proteus 765 @ 4,445 eshp.	410
	175	Britannia 320	Transport	9	139	142′ 4″	124′ 3″	37′ 6″	2,075	94,500	185,000	4 B-S Proteus 765 @ 4,445 esph.	410
The de Havilland Aircraft Co., Ltd. *Hatsfield Aerodrome, Herts*	D.H. 110	Sea Vixen	AW Fighter	2	0	50′	53′ 6½″	11′	.....	.....	.....	2 R-R Avon	M>1
	D.H. 104	Dove	Bus./Exec.	2	6	57′	39′ 3″	13′ 4″	335	5,678	8,950	2 DH Gipsy Queen 70 Mk. 3 @ 800 bhp.	200+
	D.H. 114	Heron	Transport	2	14–17	71′ 6″	48′ 6″	15′ 7″	499	8,484	13,500	4 DH Gipsy Queen 30 Mk. 2 @ 250 hp.	191
	D.H. 106	Comet 4	Transport	4	60–81	115′	111′ 6″	29′ 6″	2,121	73,600	162,000	4 R-R Avon @ 10,500 lb. t.	515
	D.H. 106	Comet 4B	Transport	4	72–102	108′	118′	29′ 6″	2,059	75,100	158,000	4 R-R Avon 29 @ 10,500 lb. t.	530
	D.H. 106	Comet 4C	Transport	4	72–102	115′	118′	29′ 6″	2,121	75,600	162,000	4 R-R Avon 29 @ 10,500 lb. t.	506
	D.H. 121	Trident	Transport	3	70–100	89′ 10″	114′ 9″	27′	1,358	62,300	105,000	3 R-R RB163 @ 10,000 lb. t.	600+

AEROSPACE CORPORATION

present genuine challenge to scientists and engineers of demonstrated competence

"To preserve our free institutions, it is absolutely essential that the United States find the most effective means of advancing the science and technology of space and also of applying them to military space systems. This is the mission of Aerospace Corporation."

IVAN A. GETTING
PRESIDENT
AEROSPACE CORPORATION

In accomplishing its mission, this nonprofit public service organization performs the unique role of space systems architect. Aerospace Corporation provides scientific and technical leadership to the science/industry team responsible for developing complete space and ballistic missile systems on behalf of the United States Air Force.

Specific responsibilities of the new corporation include advanced systems analysis, research and experimentation, initial systems engineering, and general technical supervision of new systems through their critical phases.

The broad charter of Aerospace Corporation offers its scientists and engineers more than the usual scope for creative expression and significant achievement, within a stimulating atmosphere of dedication to the public interest.

Aerospace Corporation scientists and engineers are already engaged in a wide variety of specific systems projects and forward research programs, under the leadership of scientist/administrators including corporation president Dr. Ivan A. Getting, senior vice president Allen F. Donovan, and vice presidents Edward J. Barlow, William W. Drake, Jr., Jack H. Irving, and Chalmers W. Sherwin.

Aerospace Corporation is currently seeking scientists and engineers capable of meeting genuine challenge and with proven ability in the fields of:

- Space booster project engineering
- Spacecraft design and analysis
- Aerothermodynamics
- Solid rocket research
- Nuclear rocket propulsion
- Ion and plasma propulsion
- Chemical propulsion
- Large scale weapons operations research
- Weapon system reliability planning
- Vehicle control systems

Those qualified and experienced in these and related fields are urged to direct their resumes to:

Mr. James M. Benning, Room 101, P.O. Box 95081, Los Angeles 45, Calif.

A new and vital force

AEROSPACE CORPORATION

engaged in accelerating the advancement of space science and technology

LEADING FOREIGN AIRCRAFT, MILITARY AND CIVIL CONT'D.

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Max. height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
English Electric Aviation Ltd. Aircraft Div. *100 Pall Mall, London, S.W.1.*	F. 1	Lightning	AW Fighter	1	0	34′ 10″	50′	19′ 5″	.....	.....	.....	2 R-R Avon w/reheat	M>72
	T. 4	Lightning	Trainer	2	0	34′ 10″	50′	19′ 5″	.....	.....	.....	2 R-R Avon w/reheat	M>2
	B. 6	Canberra	Bomber	2	0	64′	65′ 6″	15′ 7″	960	.....	.....	2 R-R Avon	.....
	P.R. 7	Canberra	Photo Recon.	2	0	64′	66′ 8″	15′ 7″	960	.....	24,060	2 R-R Avon	M .68
	B.(I)8	Canberra	Bomber	2	0	64′	65′ 6″	15′ 7″	960	.....	.....	2 R-R Avon	.....
	P.R. 9	Canberra	Photo Recon.	2	0	68′	66′ 8″	15′ 7″	960	.....	.....	2 R-R Avon	.....
	TSR II	.....	Strike	...	.....	.....	.....	.....	.....	.....	.....	B-S Olympus	M>2
Fairey Aviation, Ltd. *Hayes, Middlesex*	.....	Gannet A.E.W. Mk. 3	Early Warning	3	0	54′ 7″	44′	16′ 9″	.....	.....	.....	1 B-S Double Mamba @ 3,875 eshp.	.....
	.....	Gannet A.S. Mk. 4	Anti-Sub.	3	0	54′ 3″	43′	13′	482.8	15,069	21,600	1 B-S Double Mamba @ 3,035 eshp.	310
	.....	Gannet T. Mk. 5	Trainer	3	0	54′ 3″	43′	13′	.....	.....	.....	1 B-S Double Mamba @ 3,035 eshp.	.....
	.....	Delta 2	Research	1	0	26′ 9″	51′ 8″	11′	360	.....	.....	1 R-R Avon	M>1
Folland Aircraft, Ltd. *Hamble, Southampton, Hampshire*	FO. 141	Gnat Mk. 1	Fighter	1	.....	22′ 2″	29′ 8″	8′ 10″	137	4,700	6,750	1 B-S Orpheus 701 @ 4,520 lb. t.	M .98
	FO. 144	Gnat Trainer	Trainer	2	.....	24′	30′ 9″	9′ 7½″	175	5,535	7,895	1 B-S Orpheus @ 4,230 lb. t.	M>.95
Gloster Aircraft Co., Ltd. *Gloucester*	T. 3	Javelin	Trainer	2	0	52′	60′	16′	930	.....	.....	2 B.S. Sapphire 6 @ 8,300 lb. s. t.	.....
	F(AW)7	Javelin	A.W. Fighter	2	0	52′	56′ 4″	16′	930	.....	.....	2 B.S. Sapphire 7R @ 11,000 lb. s. t.	.....
	F(AW)8	Javelin	A.W. Fighter	2	0	52′	56′ 4″	.....	930	.....	.....	2 B.S. Sapphire 7R @ 11,000 lb. s. t.	.....
	F(AW)9	Javelin	A.W. Fighter	2	0	52′	56′ 4″	.....	930	.....	.....	2 B.S. Sapphire 7R @ 11,000 lb. s. t.	.....
Handley Page, Ltd. *Claremont Road, Cricklewood, London, N. W. 2*	H.P. 80	Victor B. Mk. 1	Bomber	5	0	110′	114′ 11″	28′ 1½″	.....	.....	.....	4 B-S Sapphire @ 11,000 lb. t.	.....
	H.P. 80	Victor B. Mk. 2	Bomber	5	0	120′	114′ 11″	28′ 1½″	.....	.....	.....	4 R-R Conway @ 17,250 lb. t.	.....
	H.P.R. 7	Dart Herald Series 100	Transport	2	38–44	94′ 4½″	71′ 11″	24′	886	23,000	40,000	2 R-R Dart @ 2,105 eshp.	295
	H.P.R. 7	Dart Herald Series 200	Transport	2	48–56	94′ 4.5″	75′ 5″	24′	886	.....	40,000	2 R-R R Da. 7/2 Mk. 527	.....
	H.P. 113	.....	Transport	2	8–12	71′ 3″	71′ 6″	17′	775	.....	36,500	2 B-S Orpheus @ 5,250 lb. t.	530*
Hawker Aircraft, Ltd. *Richmond Road, Kingston-on-Thames, Surrey*	P. 1127	.....	Strike Fighter	1	0	24′ 4″	41′ 2″	10′ 3″	.....	.....	.....	1 B.S. 53	Transonic
	P. 1067	Hunter F. 4	Interceptor Fighter	1	0	33′ 8″	45′ 10½″	13′ 2″	340	13,200	21,000	1 R-R Avon Mk. 122 @ 7,500 lb. s. l. s. t.	M>0.93
	P. 1099	Hunter F. 6	Interceptor Fighter	1	0	33′ 8″	45′ 10½″	13′ 2″	349	13,550	23,900	1 R-R Avon Mk. 203 @ 10,000 lb. s. l. s. t.	M>0.95
	P. 1101	Hunter T. 7	Operational Trainer	2	0	33′ 8″	48′ 10½″	13′ 2″	349	13,260	21,200	1 R-R Avon Mk. 122 @ 7,500 lb. s. l. s. t.	M>0.93
	P. 1099	Hunter F.G.A. 9	Ground Attack Fighter	1	0	33′ 8″	45′ 10½″	13′ 2″	349	13,750	24,100	1 R-R Avon Mk. 207 @ 10,000 lb. s. l. s. t.	M>0.95
	P. 1099	Hunter F.R. 10	Reconnaissance Fighter	1	0	33′ 8″	46′ 2″	13′ 2″	349	13,800	24,100	1 R-R Avon Mk. 207 @ 10,000 lb. s. l. s. t.	M>0.95
	P. 1101	Hunter T66	Operational Trainer	2	0	33′ 8″	48′ 10½″	13′ 2″	349	13,820	24,000	1 R-R Avon Mk. 207 @ 10,000 lb. s. l. s. t.	M>0.95
Hunting Aircraft, Ltd. *Luton Airport, Luton, Bedfordshire*	.....	President	Transport	2	12	64′ 6″	46′	16′	400	9,020	13,500	2 Al. Leonides @ 550 hp.	223
	P. 66	Pembroke	Multi	2	10	64′ 6″	46′	16′	400	9,178	13,500	2 Al. Leonides @ 550 hp.	223
	P. 56	Provost T. Mk. 1	Trainer	2	0	35′ 2″	28′ 9″	12′ 2″	214	3,350	4,400	1 Al. Leonides @ 550 hp.	201
	P. 84	Jet Provost T. Mk. 3	Trainer	2	0	35′ 10″	32′ 4″	10′ 2″	214	.....	6,400	1 B.S. Viper @ 1,750 lb. t.	329
Lancashire Aircraft Co., Ltd. *Samlesbury, Airfield, Blackburn, Lancashire*	EP. 9	Prospector I	Multi	1–2	5	43′ 6″	30′	10′	227.6	2,010	3,700	1 Lyc. GO-480-G1A6 @ 295 hp.	146
	.....	Prospector III	Multi	1	5	43′ 6″	29′ 9″	8′ 9″	227.6	2,345	4,600	1 Con. GTS10-520 @ 390 hp.	186
F. G. Miles, Ltd. *Shoreham Airport, Sussex*	M. 100	Student	Trainer	1	1	29′ 2″	31′ 6″	6′ 3″	144	2,400	3,900	1 Turb. Marbore II @ 883 lb. t.	298
	M. 100/2	Centurion II	Personal	1	3–4	32′ 6″	31′ 9″	7′ 4″	182	3,882	7,000	1 B-S Viper @ 2,640 lb. t. or 2 Con. J69T25 @ 1050 eshp.	419
A. V. Roe & Co., Ltd. *Greengate, Middleton, Manchester*	698	Avro Vulcan B. Mk. 2	Bomber	5	0	111′	97′ 1″	27′ 2″	.....	.....	.....	4 B-S Olympus 201 @ 17,000 lb. t.	.....
	696	Avro Shackleton Mk. 3	Anti-Sub.	10	0	119′ 10″	87′ 4″	23′ 4″	1,421	.....	100,000	4 R-R Griffon 57A @ 2,455 hp.	300
	748 Series 1	.....	Transport	3	40–44	95′	67′	24′ 10″	795	18,794	33,000	2 R-R Dart R. Da. 6 Mk. 514 @ 1,740 eshp.	294
	748 Series 2	.....	Transport	3	40–44	95′	67′	24′ 10″	795	19,694	36,000	2 R-R Dart R. Da. 7 Mk. 531 @ 2,105 eshp.	316
Scottish Aviation, Ltd. *Prestwick Airport, Ayrshire*	CC. Mk. 1	Prestwick Pioneer	Transport	1	4	49′ 4″	34′ 4″	10′ 4″	390	4,200	5,800	1 Al. Leonides 530/7 @ 540 bhp.	145
	CC. Mk. 1	Twin Pioneer	Transport	2	16	76′ 6″	45′ 3″	12′ 3″	670	10,478	14,600	2 Al. Leonides 531/8 @ 605 bhp.	173
Short Brothers & Harland, Ltd. *P.O. Box 241, Queens Island, Belfast*	S.C. 5	Belfast	Strategic Freighter	4	242	158′ 9½″	136′ 5″	47′	2,446	107,185	218,000	4 R-R Type R. Ty 12 @ 5,730 eshp.	391
	S.C. 7	Skyvan	Light Freighter	1–2	15	64′ 1″	38′ 11″	13′ 11″	373	6,030	9,300	2 Cont. GTS 10-520 @ 390 thp.	200
	S.B. 5	.....	Research	1	0	30′ 6″	45′ 9″	16′ 7″	.....	.....	.....	Bristol Orpheus	.....
	S.C. 1	.....	VTOL	1	0	23′ 6″	24′ 4″	10′ 7″	.....	.....	.....	5 R-R RB108	.....

Micrometer Precision for

ALTITUDE MEASUREMENT

the Bendix-Pacific

RADAR ALTIMETER

- 0 to 5,000 feet (can be modified to higher altitudes)
- Accuracy independent of speed
- Light weight (10.5 lbs., including indicator)
- Rugged . . . small (only 73.5 cu. in.)
- Solid state circuitry
- Low altitude reliability
- Accuracy ±5% or ±2 ft., whichever greater

THE Bendix CORPORATION

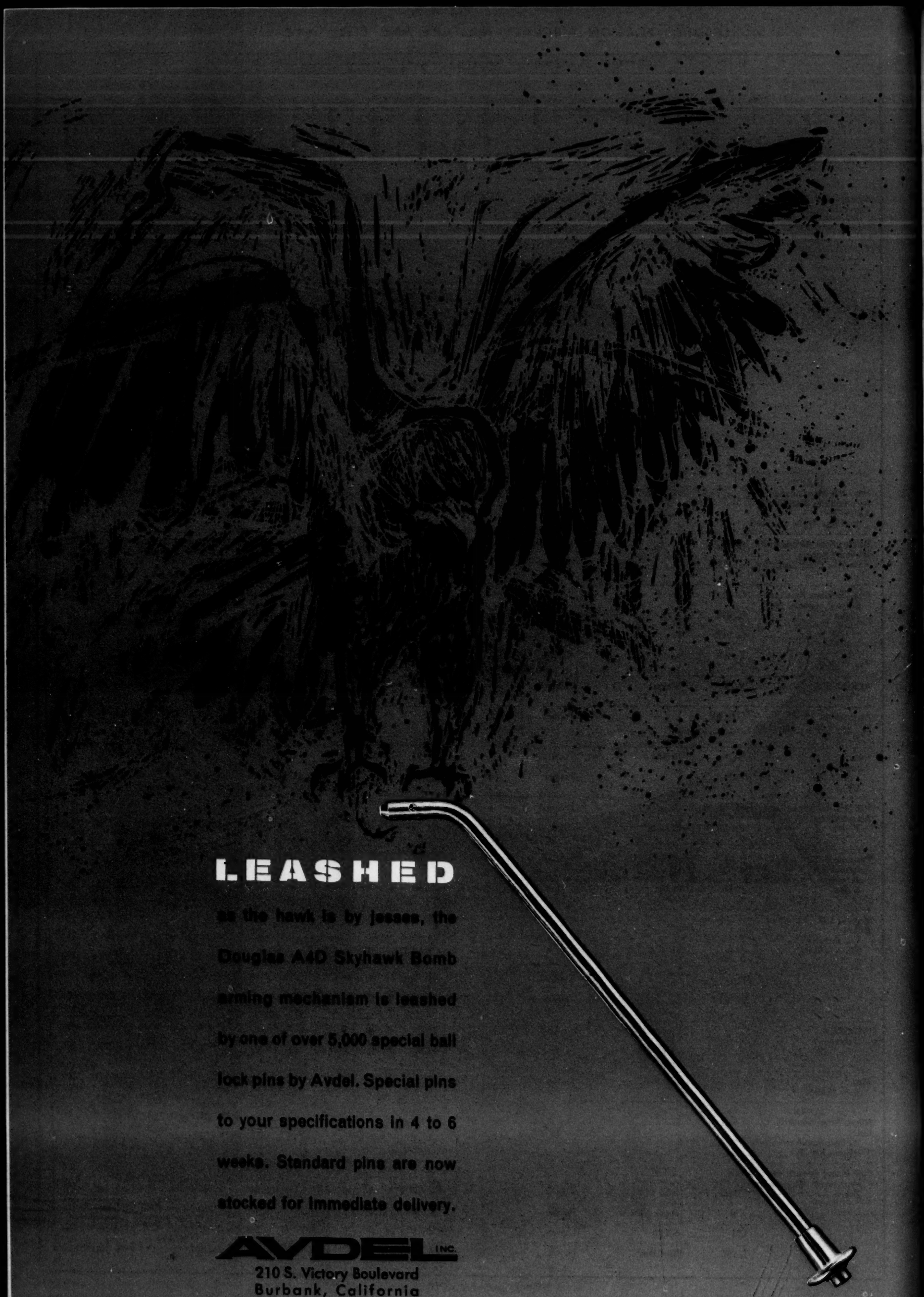
Bendix-Pacific Division

NORTH HOLLYWOOD, CALIFORNIA

Circle Number 210 on Reader-Service Card

LEADING FOREIGN AIRCRAFT, MILITARY AND CIVIL cont'd.

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Max. height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
Vickers-Armstrongs (Aircraft), Ltd. *Weybridge, Surrey*	700	Viscount	Transport	2–3	40–53	93′ 8″	81′ 10″	26′ 9″	963	36,000	62,000	4 R-R Dart R. Da. 3 Mk. 506 @ 1,540 tehp.	328
	700D	Viscount	Transport	2–3	40–63	93′ 8″	81′ 10″	26′ 9″	963	37,070	64,500	4 R-R Dart R. Da. 6 Mk. 510 @ 1,740 tehp.	345
	800	Viscount	Transport	2–3	52–73	93′ 8″	85′ 8″	26′ 9″	963	39,900	64,500	4 R-R Dart R. Da. 6 Mk. 510 @ 1,740 tehp.	340
	810	Viscount	Transport	2–3	52–73	93′ 8″	85′ 8″	26′ 9″	963	41,565	72,500	4 R-R Dart R. Da. 7/1 Mk. 525 @ 1,990 tehp.	370
	950	Vanguard Mk. 2	Transport	2–3	76–139	118′	122′ 10″	34′ 11″	1,529	80,314	14,650	4 R-R Tyne R. Ty. 11 Mk. 512 @ 5,545 tehp.	445
	1100	V.C. 10	Transport	3–5	150	140′	158′ 10″	39′ 1″	2,800	134,200	299,000	4 R-R Conway R. Co. 42 Mk. 540 @ 20,250 lb. t.	600
	VC10	Super V.C. 10	Transport	3–5	150–212	146′	186′	39′ 5″	2,800	.....	.....	.....	117.5
	.....	Scimitar F. Mk. 1	Fighter	1	0	37′ 2″	55′ 4″	15′	.....	.....	.....	2 R-R Avon 200 Series @ 11,250 lb. t.	.....
	674	Valiant B. Mk. 1	Bomber	5	0	114′ 4″	108′ 3″	32′ 2″	2,362	75,881	138,000	4 R-R Avon RA. 14 Mk.204@9,500lb.t.	M. 84
	.....	Swift F. R. Mk. 5	Fighter/Recon.	1	0	32′ 4″	41′ 5½″	13′ 6″	306	.....	21,400	1 R-R Avon RA. 7R Mk. 114 @ 9,450 lb. t.	685
	TSR. 2	.....	Strike/Recon.	...	.....	.....	.....	.....	.....	.....	.....	B-S Olympus	.....
ITALY													
Industrie Meccaniche Aeronautiche Meridionali-AERFER *50, Corso Malta, Naples*	.....	A.S. Sagittario II	Fighter	1	0	24′ 7″	31′ 2″	6′ 7″	158	4,960	7,160	1 R-R Derwent 9 @ 3,600 lb. t.	620
	.....	Ariete	Fighter	1	0	24′ 7″	31′ 6″	.....	.....	5,291	.....	1 R-R Derwent+1 R-R Soar	M=1.1
Construzioni Aeronautiche Giovanni Agusta *Cascina Costa, Gallarate*	AZ-8L	.....	Transport	2	22	83′ 8″	63′ 9″	21′ 8″	719	.....	23,810	4 Al. Leonides Mk. 22 (503/2) @ 470 hp.	252
	AZ-8S	.....	Transport	2	22	83′ 8″	63′ 9″	21′ 8″	719	.....	23,810	4 SNECMA 12S @ 575 hp.	.....
Fiat-Divisions Aviazione *Corso G. Agnelli, 200, Turin*	G. 91	.....	Fighter	1	0	28′ 1″	34′ 2½″	13′ 1″	176.7	.....	11,350	1 B-S Orpheus B. Or. 80,302 @ 4,850 lb. t.	M>1
	G. 91T	.....	Trainer	2	0	28′ 2″	39′ 3″	13′ 9″	176.7	7,100	11,775	1 B-S Orpheus B. Or. 80,302 @ 5,000 lb. t.	640
	G. 91R	.....	Photo. Recon.	1	0	28′ 1″	34′ 2½″	13′ 1″	176.7	.....	.....	1 B-S Orpheus B. Or. 80,302 @ 5,000 lb. t.	M>1
	F. 86K	.....	Fighter	1	0	37′ 2″	40′ 1″	15′	288	.....	18,000	1 GE J47-GE-17B @ 7,350 lb. t.	650
AEROMERE *Trento*	F. 8L	Falco	Tourist	1	1	2.62	22.32	7.11	107	1,177	1,650	1 Lyc. O-320-A @ 150	208
Aeronautica Macchi *Corso Vittorio Emanuele 31, Milan*	C.L. 402	.....	Trainer	2	4	39′	28.09	10.67	144	2,024	3,740	1 Con. IO-470-R; @ 260 hp.	.....
Aviamilano Costruzioni Aeronautiche *Via Macedonio Melloni 70 Milan*	F. 14	Nibbio	Tourist	1	3	31.18	25.07	8.08	138	1,551	2,508	1 Lyc. O-360-A2A @ 180 hp.	205
	P. 19	.....	Trainer	1	1	33.60	23.07	6.63	150	999	1,440	1 Con. C. 90-12F @ 95 hp.	130
METEOR-Costruzioni Aeronautiche *Trieste*	FL 54BM	Meteor Tris	Personal	1	2	31′ 4″	22′	6′ 1″	155	959	1,543	1 Meteor G90 CA @ 90 hp.	120
	FL 55DM	Meteor Super	Personal	1	3	31′ 4″	22′ 4″	6′ 1″	155	1,146	1,984	1 Meteor G180 CA @ 180 hp.	140
Partenavia Construzioni Aeronautiche *Aeroporto, Forlanini, Milan*	P. 57	Fachiro II	Tourist	1	3	29.99	21.62	8.70	143	1,386	2,310	1 Lyc. O-360-B @ 170 hp.; 1 Lyc. O-360-A @ 180 hp.	149
	P. 59	Jolly	Training	1	1	33.50	21.52	6.96	162	1,188	1,650	1 Con. C. 90-12F @ 95 hp.	128
Piaggio & C., Societa pe Azioni *Via Antonio Cecchi 6, Genoa (434)*	P. 136-L1	.....	Personal	1	4	44′ 5″	35′ 5″	12′ 7″	270	4,420	6,000	2 Lyc. GO-480-B1A6 @ 270 hp.	184
	P. 136-L2	.....	Amphibian	1	4	44.40	35.43	12.57	269	4,356	6,600	2 Lyc. GSO-480-A1A6 @ 340 hp.	213
	P. 149-D	.....	Tourist	1	4	36.49	27.96	9.36	201	2,585	3,696	1 Lyc. GO-480-B1A6 @ 270 hp.	192
	P. 166	.....	Transport	1	7	46.68	38.06	16	284	5,280	8,096	2 Lyc. GSO-480-B1C6 @ 340 hp.	226
	P. 155-CT	.....	Amphibian	4	30	102′ 6″	98′ 5″	31′ 10″	1,078	32,000	53,000	2 All. 501-D13 @ 3,750 eshp.	350
PROCAER *Milano*	.....	Cobra 400	Touring	1	1	28.54	25.60	9.19	125	1,760	3,080	1 Turbomeca Marbore II @ 400 Kg.	380
	.....	Picchio F. 15	Personal	1	3	30.51	24.60	9.19	131	8,096	2,420	1 Lyc. O-360-A @ 180 hp.	186
SIAI *Sesto Calende*	FN. 333	.....	Amphibian Tourist	2	2	34	24.01	10.53	161.5	2,112	3,267	1 Con. IO-470-4 @ 240 hp.	180
JAPAN													
Nihon Aeroplane Mfg. Co., Ltd. *Minami-Sakumacho Shiba, Minato-Ku, Tokyo*	YS-11	.....	Pass. Trans.	3	52–60	105′	86′ 3″	30′	1,020	30,093	50,265	2 R-R Dart R. Da.-10/1 @ 2,660 eshp.	.....
Fuji Heavy Industries, Ltd. *Marunouchi Chiyoda-Ku, Tokyo*	T1A	T1F2	Trainer	2	.....	36′ 7″	39′ 7″	13′ 3″	239	6,065	10,700	1 Orpheus Mk. 316 @ 4,000 lb. t.	560
	T34A	B-45 Mentor	Trainer	2	.....	32′ 9″	25′ 9″	9′ 5″	178	2,246	2,980	1 Con. O-470-13 @ 225 hp.	188
	KM	Super Nikko	Liaison	1	4	32′ 8″	26′ 0″	9′ 5″	177.6	2,400	3,850	1 Lyc. GSO-480-B1A6 @ 340 hp.	225
	LM	Nikko	Liaison	1	4	32′ 8″	26′ 0″	9′ 5″	177.6	2,104	3,527	1 Con. O-470-13A @ 225 hp.	185
	L-19E	Bird Dog	Liaison	1	1	35′ 9″	24′ 9″	7′ 5″	174	1,658	2,340	1 Con. O-470-11 @ 213 hp.	127



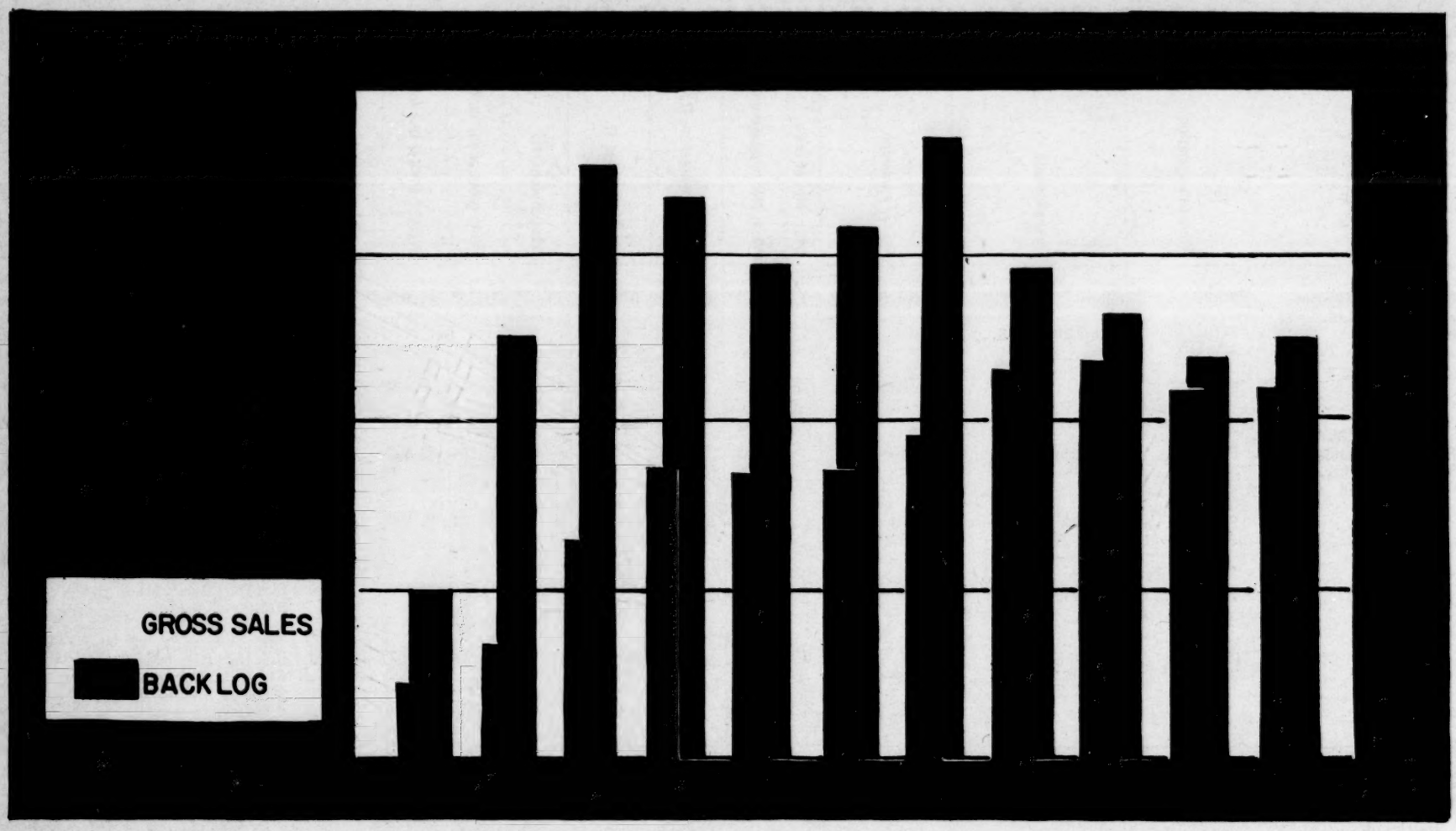
LEASHED

as the hawk is by jesses, the Douglas A4D Skyhawk Bomb arming mechanism is leashed by one of over 5,000 special ball lock pins by Avdel. Special pins to your specifications in 4 to 6 weeks. Standard pins are now stocked for immediate delivery.

AVDEL INC.
210 S. Victory Boulevard
Burbank, California

LEADING FOREIGN AIRCRAFT, MILITARY AND CIVIL cont'd.

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Max. height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
Mitsubishi Industries Reorganized, Ltd.	F-86F	Sabre	Fighter-Bomber	1	.....	39′ 1″	37′ 6″	14′ 7″	313′ 3″	11,019	20,245	1 GE J47-GE-27 @ 6,090 lb. t.	669
Aircraft Dept.	F-104J	Star Fighter	Fighter	1	.....	.....	.....	.....	.....	.....	.....	1 GE 779-GE-7	.....
Chiyoda-Ku, Tokyo	S-55A	.....	Utility	1–2	10	.....	42′ 3″	13′ 4″	.....	4,880	7,200	1 P&W Wasp S1H2 (R-1340-57) @ 600	110
	S-55C	.....	Utility	1–2	10	.....	42′ 3″	13′ 4″	.....	5,180	7,900	1 Wright (R1300-3) @ 700	101
NETHERLANDS													
Royal Netherlands Aircraft Factories (Fokker)	F-27	Friendship	Transport	2	40–52	95′ 2″	77′ 2″	27′ 6″	754	22,000	42,000	2 R-R Dart RDa. 6 Mk. 511 @ 1,720 eshp. or 2 R-R Dart RDa. 7 Mk. 528 @ 2,105	.....
Schiphol-Zuid, Amsterdam	F-27	Friendship DeLuxe	Transport	2	16	95′ 2″	77′ 2″	27′ 6″	754	23,600	42,000	2 R-R Dart RDa. 6 Mk. 511 @ 1,720 eshp. or 2 R-R Dart RDa. 7 Mk. 528 @ 2,105	.....
	F-27	Freightship	Pass./Cargo	2	32–40	95′ 2″	77′ 2″	27′ 6″	754	22,558	42,000	2 R-R Dart RDa. 6 Mk. 511 @ 1,720 eshp. or 2 R-R Dart RDa. 7 Mk. 528 @ 2,105	.....
	F-27M	Troopship	Military Transport	2	45	95′ 2″	75′ 9″	27′ 6″	754	21,395	39,000	2 R-R Dart RDa. 6 Mk. 511 @ 1,720 eshp. or 2 Dart 7 Mk. 528 @ 2,105 shp.	.....
SPAIN													
Construcciones Aeronauticas, S.A.	C-201	Alcotan	Transport	3	10	60′ 5″	45′ 8″	13′ 0″	450	8,437	12,125	2 Enmasa Sirio 7E-C20 @ 500 hp.	211
Calle del Rey Francisco, 4 Madrid (8)	C-202	Halcon	Transport	3	14	70′ 10″	52′ 6″	19′ 11″	618	11,828	17,085	2 Enmasa Beta B-41 @ 775 hp.	230
	C-202B	Halcon	Business	2	6	67′ 6″	53′ 7″	20′ 11″	603	13,385	21,275	2 Wright R1820-56 @ 1300	268
	C-207	Azor	Transport	4	30–40	91′ 2″	68′ 5″	25′ 5″	924	22,024	34,500	2 Bristol Hercules 730 @ 2,040 hp.	285
	C-1131	Bucker	Trainer	2	.....	24′ 2″	22′ 1″	7′ 4″	145	1,000	1,580	1 Enmasa Tigre G-N-A @ 125 hp.	122
	C-127	Dornier	Liaison	1	4	39′ 5″	31′ 5″	11′ 5″	210	2,300	3,500	1 Lyc. GO-480-B1A6 @ 274 hp.	155
Aeronautica Industrial, S.A.	AISA I-115	.....	Primary Trainer	2	.....	31′ 3″	24′ 1″	6′ 10″	150.6	1,346	1,980	1 Enmasa Tigre G-IV-B @ 150 bhp.	.....
Plaza de las Cortes, 2 Madrid 14	AISA I-11B	.....	Touring or Training	1	1	30′ 7″	21′ 3″	6′ 3″	144	926	1,474	1 Con. C-90 12F @ 95	.....
	AISA AVD-12C	.....	Liaison or Touring	1	3	36′ 5″	25′ 5″	6′ 10″	193	1,664	2,866	1 Con. O-470-A @ 225	.....
	AISA AVD-12	.....	Liaison or Ambulance	1	2–3	36′ 5″	25′ 5″	6′ 10″	193	1,576	2,425	1 Enmasa Tigre G-IV-B @ 150 bhp.	.....
La Hispana-Aviacion, S.A.	HA-100-F1	Triana	Adv. Trainer	2	.....	34′ 1″	29′ 5″	9′ 9½″	186.6	4,340	6,440	1 Wright Cyclone 957C7BA1 @ 800 hp.	279
Calle San Jacinto 108–106 Sevilla	HA-100-E1	Triana	Adv. Trainer	2	.....	34′ 1″	29′ 5″	9′ 9½″	186.6	4,360	6,460	1 Enma Beta B-4 @ 755 hp.	275
	HA-200-R1	Saeta	Adv. Trainer	2	.....	34′ 2″	29′ 1″	10′ 8″	187.2	3,695	6,995	2 Turbomeca Marbore 11A @ 880 lb. t.	435
SWEDEN													
Svenska Aeroplan Aktiebolaget	Saab-J29F	Tunnan	Fighter	1	0	36′ 1″	33′ 2″	12′ 3″	258	9,480	13,360	1 Sven. RM-2 @ 6,175	660
Linkoping	Saab-32A	Lansen	AW Attack	2	0	42′ 8″	48′ 1″	15′ 8″	401	15,500	28,665	1 Sven. RM-5 @ 9,500	700
	Saab-J32B	Lansen	AW Interceptor	2	0	42′ 8″	48′	15′ 6″	401	.....	.....	1 Sven. RM-6 @ 15,000 lb. t.	700+
	Saab-32C	Lansen	Photo-Recon.	2	0	42′ 8″	48′ 1″	15′ 8″	.....	15,500	27,563	1 Sven. RM-5 @ 9,500	700
	Saab-35A	Draken	AW Fighter	1	0	30′ 10″	53′	12′ 10″	538	20,000	16–18,000	1 Sven. RM-6 @ 15,000 lb. t.	M. 1.8
	Saab-J35B, C	Draken	AW Interceptor	1	0	30′ 10″	53′ 4″	12′ 10″	538	20,000	16–18,000	1 RR RB.146 @ 13,200 lb. t.	M>2
	Saab-90A-2	Scandia	Transport	3	40	91′ 11″	69′ 11″	23′ 3″	922	21,960	35,270	2 P&W R2180-E1 @ 1,800 hp.	277
	Saab-91B	Safir	Trainer	3	0	34′ 9″	26′	7′ 2″	146	1,580	2,315	1 Lyc. O435-A @ 190	170
	Saab-91C	Safir	Personal	1	3	34′ 9″	26′	7′ 2″	146	1,625	2,685	1 Lyc. O435-A @ 190	169
	Saab-91D	Safir	Trainer	3–4	0	34′ 9″	26′	7′ 2″	146	1,570	2,660	1 Lyc. O360 @ 180 hp.	169
	Saab-J35C	Draken	Dual contr. Trainer	2	.....	30′ 10″	53′	.....	.....	.....	18,000	1 Sven. RM-6 @ 15,000 lb. t.	.....
SWITZERLAND													
Flug- & Fahrzeugwerke A.G.	P-16	.....	Ground Attack	1	.....	36′ 7″	47′	14′	323	15,500	25,500	B-S Sa. 7 @ 11,000 lbs. @ 8,600 rpm.	700
Altenrhein bei Rorschach													
Pilatus Flugzeugwerke A.G.	P-3	.....	Trainer	2	0	34′ 1″	28′ 8″	10′	177	2,447	3,120	1 Lyc. GO-435-C2A @ 260 hp.	192
Stans, Nr. Lucerne	PC-6	Porter	Multi	1	5–7	49′ 10″	34′ 5″	10′	.....	2,400	3,960	1 Lyc. GSO-480-A7-A6 @ 340 hp.	.....
WEST GERMANY													
Aero-Jodel	D-11A	Aero-Jodel Club	Personal	1	1	27′	21′ 4″	6′ 9½″	.....	838	1,433	1 Cont. A-65/8 @ 65 hp.	.....
Aero Flugzeugbau Hubert Zuerl, Munich-Heimstetten	D-11C	Aero-Jodel Club	Personal	1	1	27′	21′ 4″	6′ 9½″	.....	838	1,433	1 Cont. C-90/12F @ 95 hp.	.....
Dornier-Werke GmbH.	Do. 27 Q5	.....	Multi	2	4	39′ 4″	31′ 5″	8′ 9″	209	2,490	4,080	1 Lyc. GO-480-B1A6 @ 270 hp.	.....
Friedrickshafen a B.	Do. 28	.....	Multi	2	4	46′ 5″	29′ 6″	10′ 4″	262.3	3,750	5,390	2 Lyc. O-540-A1A @ 250 hp.	.....
Scheibe-Flugzeugbau G.m.b.H.	SF-23A	Sperling	Utility	1	1	32′ 4½″	20′ 4″	7′ 2″	130.7	1,015	1,610	1 Con. C90-12F @ 95 bhp.	124.5
Dachen	SF-23B	Sperling	Utility	1	1	32′ 4½″	20′ 4″	7′ 2″	130.7	1,015	1,610	1 Con. O200-A @ 100 bhp.	127.5
	SF-23C	Sperling	Utility	1	1	32′ 4½″	20′ 4″	7′ 2″	130.7	1,058	1,610	1 Lyc. O-235-C1 @ 115 bhp.	134



TEN-YEAR RECORD of aerospace industry sales and backlog—1960 estimated—as reported by the Aerospace Industries Assn. Other estimates—the SEC-FTC survey—indicate higher 1960 sales of approximately $12.5 billion.

R&D Costs Temper Financial Outlook

By William H. Gregory

Aerospace companies might reasonably expect a better year in 1961 than 1960 with its spasm of write-offs—especially if a rising stock market is a reliable barometer.

On the plus side of the scale is the size of the market, forecast to equal 1960's total of $12.5 billion. This includes National Aeronautics and Space Administration and commercial sales as well as military.

What concerns many managements is on the other side of the scale. Besides the old standbys of low profit margins, intense competition and technological transition, there is a growing problem summed up by one executive's phrase "sharing the wealth," or its related manifestation, buying a hand in major competitions.

Assuming the industry really has purged itself of drastic charges against earnings, companies should be in a far healthier condition this year. One former aerospace company financial officer who now looks at the industry from outside believes companies who took their baths last year are now in their soundest condition in five years.

Profit Pressure

Or will companies find the spectacular write-offs of the commercial jet programs that brought deficits to a few replaced for all by costs of company funded research and development, diversification, or overoptimistic and overcompetitive bidding that drain profits even while not erasing them entirely? How deep the share-the-wealth problem and its corrallaries cuts today is a matter of conjecture. It's unlikely though that any company has escaped some measure.

Three years ago the Defense Department began to insist on more company sponsored programs, on products the military could buy on an off-the-shelf basis. Then last year, a new procurement regulation tightened the strap further by requiring companies to share the costs of company sponsored R&D that formerly was covered in overhead.

The fundamental reasons given were understandable. With budgets squeezed, the Defense Department found it was holding the tab for many projects in which it had no strong current interest, that it had no control over the burgeoning industrial R&D effort. In some cases, especially in the avionic field, the government also found itself paying for development of a profitable commercial product.

Industry has said little publicly since it is obviously hard to quarrel with the aims of the program. But privately there is a feeling in specific cases the military has denied a requirement for a system or product that the manufacturer believed did exist. This, if true, would mean more of the trend that started with cuts in progress payments in 1957 to shift some of the government's financing problems to industry.

Negotiations have been under way between cognizant services and about 40 companies over sharing percentages for 1961. General Electric's position underscores the area of military-industry disagreement.

GE might be willing to accept a flat dollar limitation, or even sharing in some form, but it opposes the principle of the military negotiators that sharing

Biggest Problem of Defense Business?

Doing business with the government has a set of problems all its own. But in analyzing them, the comment of a major avionic company should be kept in mind:

"Our biggest complaint about the defense business is that we don't have enough of it."

begins with the first dollar. In effect, GE thus is fighting the theory that no company-sponsored project should be supported 100%.

Most companies feel that the average percentage for all companies will wind up around 50%. Only Grumman so far has given any indication of the cost to industry when it wrote off $814,000 after taxes in making adjustments for sharing in the third quarter last year.

Though not catastrophic, such costs represent in the industry view another hard turn or two in the screws tightening down profits and offer little encouragement of any salve being applied to complaints over declining margins.

United Aircraft Corp. Chairman H. M. Horner discussed the R&D problem in detail in a recent speech to the Boston Society of Security Analysts, the significant passages of which follow:

". . . United covers its R&D in three ways. First is direct research and development contracts from the customer, usually the government. These can be cost-plus or fixed-price and you may be surprised to know that better than 50% of our direct R&D contracts are fixed price. Sometimes we take an awful beating—but we feel it's worth it because we have quite a measure of freedom from government interference . . .

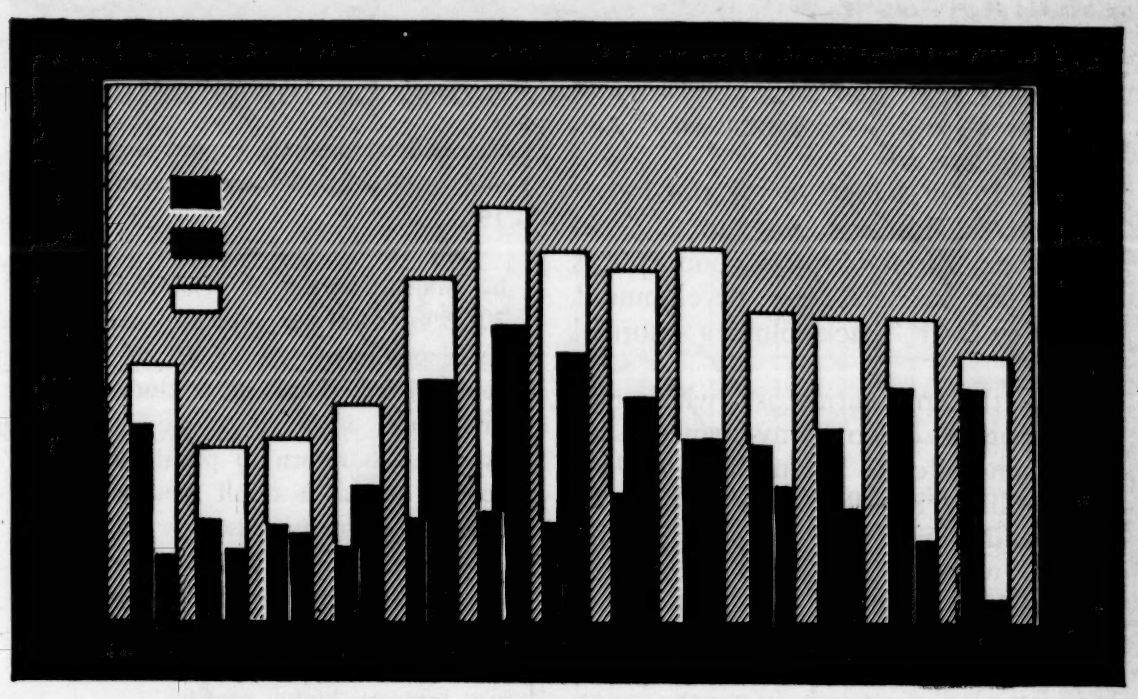
Alternate Method

"The second way is through across-the-board allocation as overhead. In this case, based on product cost the research and engineering expense is prorated regardless of whether the customer is the military or commercial. These two ways were the only ways of absorbing our R&D until three years ago.

"At that time the military started to pick and choose which projects it would permit to be covered in across-the-board overhead absorption regardless of whether the product in question had military potential. To provide for our future as we saw it, we felt we had to go ahead with certain projects even though the military refused to accept the engineering costs in overhead.

"It is this class of R&D project which we now refer to as 'company-financed' and is the third way United at present covers its R&D although 'cover' is a painful description for it is right out of profits.

"Our 3,000 lb. thrust jet, the JT12, which has the military designation J60, is an example of this third category. While the military refused to accept the engineering and development costs in current overhead, it did agree to accept such charges as an element of cost if and when it procured the engine. This in effect meant capitalizing the engineering expense as far as govern-



U. S. Aerospace Employment

(In Thousands)

YEAR	Aircraft	Acft. Engines and Parts	Props and Parts	Other Acft. Parts and Equipment	Total
1960*	221.1	77.6	7.0	75.5	381.2
1959	268.1	86.5	9.1	87.4	451.1
1958	291.3	89.9	12.2	85.8	479.3
1957	340.9	111.3	13.9	97.5	563.6
1956	326.8	105.3	11.3	94.0	537.4
1955	319.4	95.3	9.4	82.6	506.6
1954	331.4	109.1	11.2	89.7	541.4
1953	343.0	124.7	13.3	88.0	568.7
1952	311.6	98.8	10.4	62.7	483.5
1960*	379.7	134.0	12.3	127.4	653.4
1959	435.0	146.3	14.4	139.2	734.9
1958	456.8	152.7	18.3	129.7	757.5
1957	522.3	179.1	20.5	139.8	861.7
1956	494.4	167.1	16.9	130.9	809.3
1955	466.6	147.1	13.8	113.0	740.5
1954	470.0	159.4	15.8	118.9	764.1
1953	472.4	174.7	17.7	114.2	779.1
1952	425.9	138.8	14.5	81.6	660.7
1960*	$2.72	$2.72	$2.56	$2.67	$2.70
1959	2.64	2.64	2.47	2.58	2.62
1958	2.51	2.54	2.38	2.49	2.51
1957	2.35	2.39	2.35	2.37	2.36
1956	2.27	2.28	2.27	2.29	2.28
1955	2.17	2.17	2.18	2.17	2.17
1954	2.08	2.09	2.09	2.08	2.08
1953	1.99	2.03	2.05	1.99	2.00
1952	1.87	1.98	2.05	1.88	1.90

* Preliminary figures

ment pricing went, although, of course, you understand that on United's books all research and development is written off as incurred.

"Well, I'm happy to say the J60 is now in the military program . . . So we hope through production prices some day to get our development expense 'bait' back—plus a normal profit.

"For the corporation as a whole this unsupported, or company-financed, expense amounted to $11 million in 1958, $28 million in 1959 and just under $40 million in 1960. Looking to the future, we expect it will amount to some $50 million in 1961 and maybe around $60 million in 1962 . . . "

Horner did not mention the effect of the more recent sharing edict, but told AVIATION WEEK later this has meant that United simply had to drop some worthwhile projects since enough funds were not available.

Two military airplanes which the J60 engine powers, North American's T-39 Sabreliner and the Lockheed C-140 JetStar, were company funded as the engine was. It was nearly $30 million in capitalized JetStar costs Lockheed wrote off in mid-1960 that made up about half of its first six months deficit.

Thus the effect of company-supported projects on earnings is painfully clear. The big question still remaining: will enough company-funded projects eventually wind up in the program at all or at prices that will cover their development costs?

Procurement Dilemma

Effect of the related problems of overoptimistic bidding, buying hands and price cutting is not so clearly delineated. Compounding these manifestations of increased competition is plight of the procurement officer with the Congressional Small Business Committee or the General Accounting Office peering over his shoulder. Perhaps to protect himself he feels he must seek competitive bids on a development primarily based on a proposal from a single company, a situation that breeds price shaving and complaints of proprietary give-aways. Similarly, the procurement officer may find himself facing the dilemma of a low bid of questionable competence versus a higher bid backed by superior engineering and production skills. Either decision is apt to be criticized.

Avionic companies find another set of problems in still another related area. These arise in contracts under the new AGREE (AW June 13, p. 87) reliability procedures. Hoffman Electronics was first to undertake a major production contract under the procedures, for ARN-21C Tacan sets. To meet the requirements necessitated such drastic revision of Hoffman's internal production methods that had been satisfactory for production of the predecessor ARN-21B sets that Hoffman reportedly lost $8 million on the $40 million contract.

A more or less similar gamble, that potential development problems might not be as costly as feared, worked out unfavorably for Thiokol Chemical Corp. on its Minuteman solid propellant first stage contract. Cost overruns on this program contributed substantially to cutting Thiokol profits for the first nine months of 1960 from $8.4 million the year before to $5.5 million and prevented entering later, more profitable phases of the program.

Controversy arose over pricing in NASA's 200K liquid hydrogen rocket engine award to Rocketdyne. Aerojet-General, which bid $66 million, said Rocketdyne's $44 million price did not cover certain test phases NASA would later ask for—though NASA has not revised the contract and it still stands at the original figure. The issue may still be aired in Congress.

Aerospace companies confront a group of problem areas, any one of which, like the foregoing, could have severe repercussions on the industry or individual companies:

• **Consolidations.**

Too many companies are seeking too little business, in the opinion of many industry leaders and a need for some sort of consolidation as that Britain undertook is often recommended. But as practical fact, most companies have held out for mergers that would strengthen their own capabilities to compete rather than reduce the number of competitors. Textron's acquisition of Bell Aircraft last year falls in the latter category.

Forced combinations as those in Britain are unlikely in the U. S., but the situation is ripe for involuntary acquisitions on the order of Ling-Temco's effort to buy control of Chance Vought Corp. or Martin Co.'s purchase of General Precision Equipment Corp. stock after its offer of acquisition by exchange of stock was rejected. Suits charging anti-trust violation filed by both Chance Vought and GPE indicate the resistance to be expected by managements to unwelcome consolidation.

Favorable Climate

Even so, a variety of circumstances will still favor further moves of this sort. Aggressive managements of companies that have amassed sizable net worths during the last decade, backed by Wall Street interests keenly aware of the bullish market for stocks with the right technological aura, will continue to find attractive acquisitions to expand their own capabilities.

Their sometimes unwilling partners in marriage may have assets besides technical skills: funds not put to use effectively in the business itself or in diversification, or prospective drop in volume that makes stockholders susceptible to a proxy solicitation, or a lack of financial sophistication that has left their share prices in a relatively disadvantageous position with companies that have learned to keep their Wall Street fences mended.

• **Diversification.**

For the company that recognizes one horn of this dilemma—that it cannot afford not to diversify—may also soon face the other: that it has not benefited diversification either.

Most aerospace companies now recognize that diversification outside their own marketing experience is bucking the odds. Curtiss Wright ventured into the textile field with its Curon plastic and wound up selling the process to a textile company. Chance Vought's initial year in the mobile home business was admittedly a disappointment.

Even diversification within one's own capabilities may be an excursion into the desert. Witness the experience of the turbine transport manufacturers, none of which were novices in the com-

Sales, Earnings Estimates

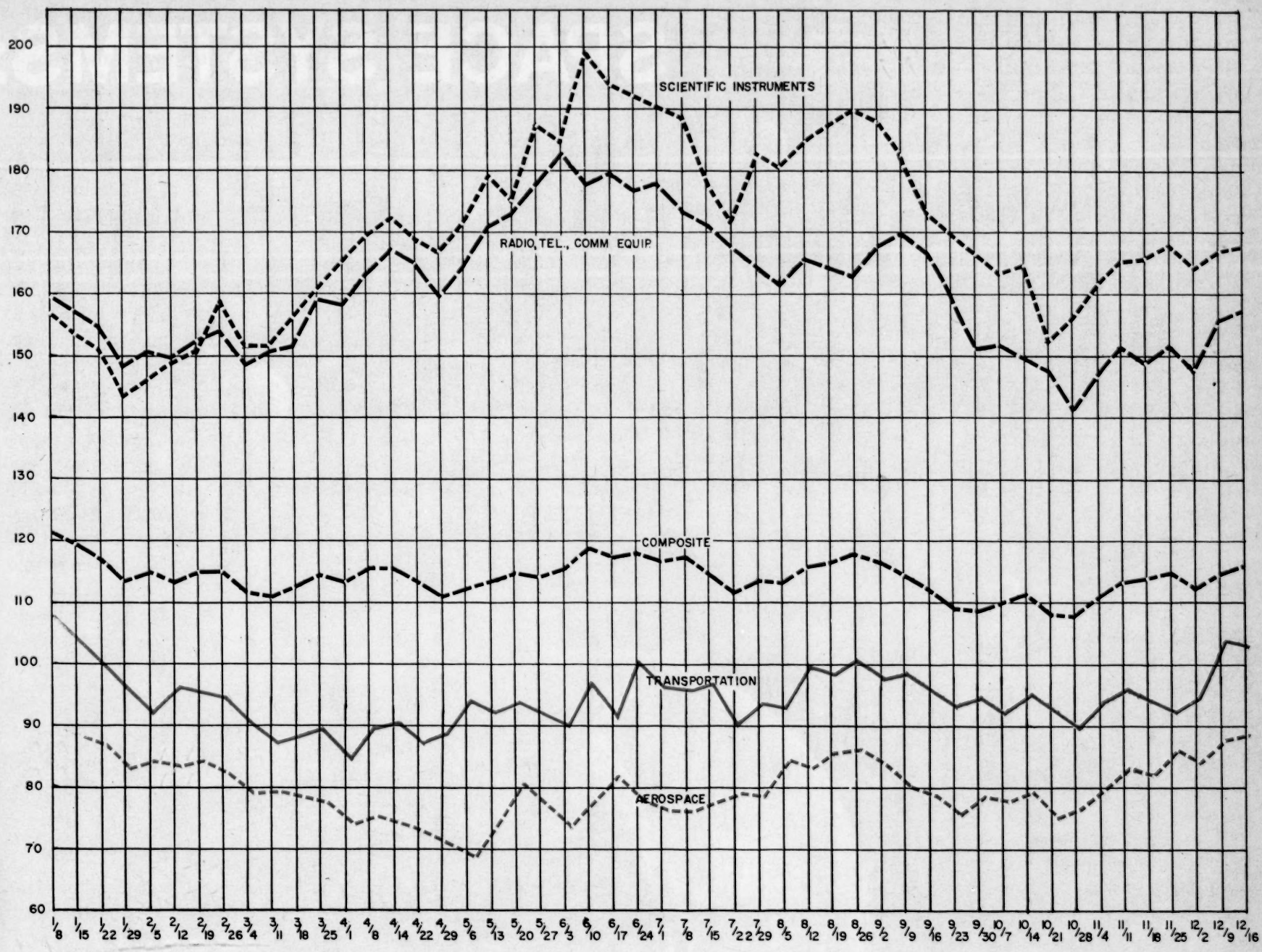
Financial analysts expect higher sales and profits for aerospace companies in 1961.

One investment company projection, by Smith, Barney & Co., indicates a 20-25% earnings increase over 1960 based on an average of 19 of 22 companies listed. Three are excluded in this calculation since they are companies expected to return to profitability after deficits and as a result would tend to overweight the increase.

Standard & Poor's expects dollar volume in 1961 to rise 5-10% over total 1960 sales estimated at $11 billion based on reports from 52 companies. It likewise forecasts higher profits.

Both Aerospace Industries Assn. and Standard & Poor's $11-billion 1960 sales estimate is more conservative than Securities and Exchange Commission and Federal Trade Commission survey estimate of approximately $12.5 billion. Though not directly comparable with Federal fiscal year budgets, the budget figures would seem to support the higher total.

Projections based on latest SEC-FTC reports indicate overall industry profits of $160-180 million for 1960. Profit margin on sales after taxes was running at about 1.4% and on net worth about 7%. Margins on both sales and net worth were approximately 3% under manufacturers generally.



AEROSPACE manufacturers and airline stock prices ran below the general market average last year. Figures are from SEC with an index level of 100 based on 1957-59 prices. Note electronic and instrument company stocks, these also figured in the aerospace market.

mercial airplane field. Only Boeing, with reorders trickling in for existing 707 versions or new orders for new members of the family as the 727, seems to have a reasonable chance of recovering its investment at this point.

Martin Co. believes the primary question is what fields not to enter. Martin President W. B. Bergen commented recently: "Every day we resist plans to diversify into fields in which we are very capable indeed, but which do not fit our overall concepts."

Martin, he said, could have gotten deeper into building Titan intercontinental ballistic missile sites, but Martin decided it was a defense contractor and not in the construction business.

Bergen scoffed at the concept of cutting down defense volume and replacing it with commercial business, a viewpoint in which he is not alone. Despite the low profit margins and potential contract cancellations in the defense business, Martin specializes in defense and intends to stick to its specialty, Bergen said.

Program cancelations need not be fatal, he said, if a contractor recognizes that some weapons inevitably will become obsolete and has done the planning to have successor programs coming along in various stages of development.

Risks of defense contracting are more or less the same as any other business, and Bergen added that defense contractors are often insulated from the fluctuations of pure commercial enterprise. Furthermore, he contends, cost-plus business can produce a reasonable profit if the contractor is skilled enough to hold down costs.

Point of View

From this, it is apparent that any analysis of the problems of aerospace companies depends a great deal on point of view.

• **Attitude of the new administration on defense spending.**

Not only is this as yet an unanswered question, but the possibilities of new moves for disarmament are major uncertainties for the industry. However, Russia's Venus shot and its aggressiveness in the Congo and Laos would seem to indicate little de-emphasis in either U. S. military or space programs on the short term.

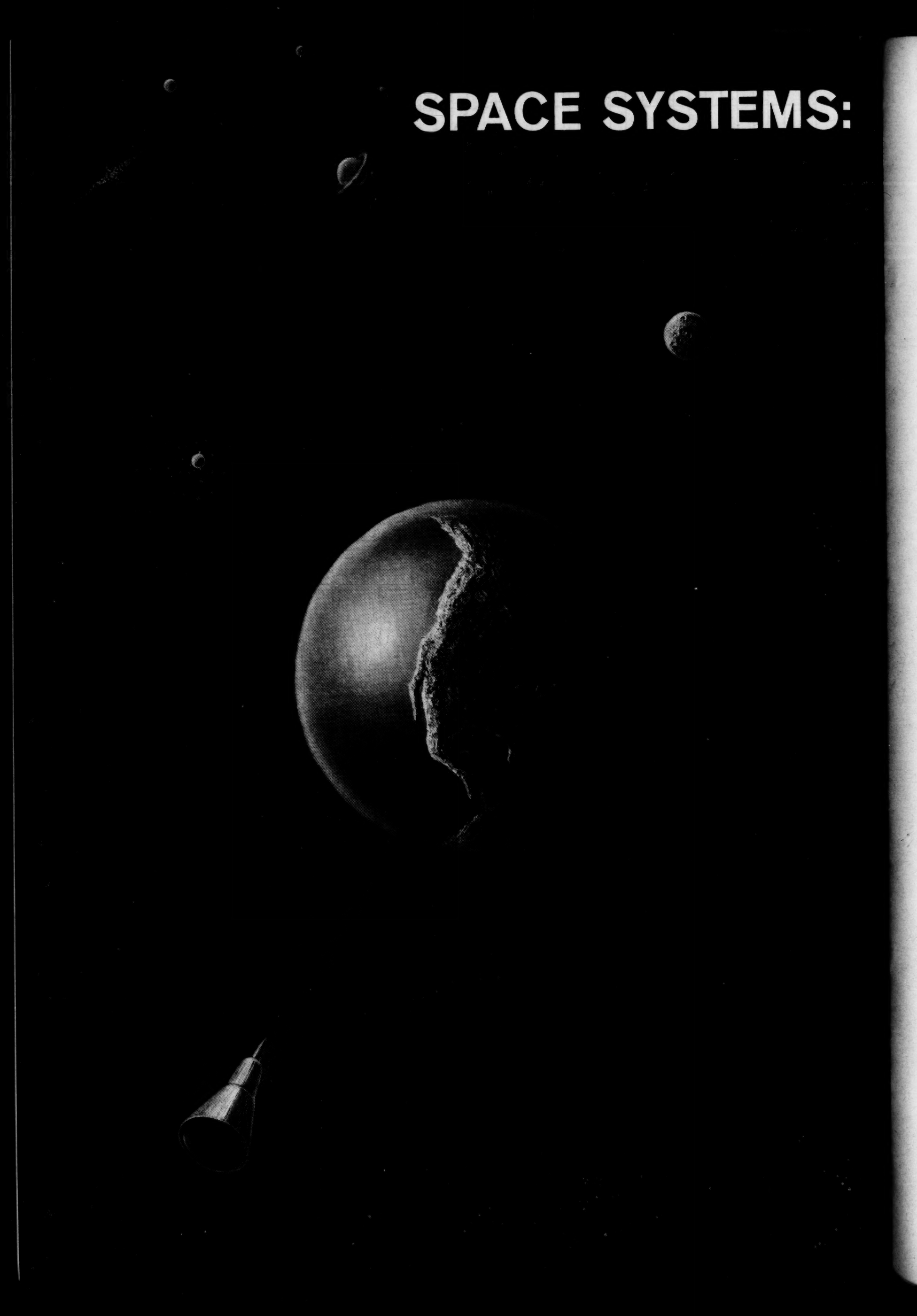
In important areas of civil aviation there were optimistic signs, but also some dissenting voices:

• **Airlines** had a disappointing 1960 when profits fell to $4 million for trunk carriers, the lowest since 1949. But some financial analysts detected what they felt were indications the cost curve was turning down after a long, disconcerting rise. As a result, airlines stocks perked up at a time when earnings were at low ebb.

• **Business aircraft** manufacturers felt their markets would continue to grow. Yet declines in general business had them watching carefully for trouble. One manufacturer, Piper, bluntly forecast lower earnings, not only because of start-up costs of a new plant, but also because of an expected switch by customers to lower price aircraft as the economy retrenched.

Problems similar to those of the automotive industry are being encountered by the business plane makers. Inventories of 1960 airplanes were high at year end, and production cutbacks are the result at the factories. Customers, concerned by the recession, are shopping around carefully and delaying purchases often.

SPACE SYSTEMS:



finally jerked free; his parachute opened only 250 feet from the ground. He landed amid constant shelling and sporadic gassing. Painfully wounded in the head and lightly gassed, Udet escaped to his lines.

The next day, he climbed into a new Fokker and shot down a SPAD for his 36th kill.

It was June, 1918. The D. VII, then new in service, was making a valiant effort to recapture air supremacy for Germany. Powered by Mercedes or B.M.W. engines in a range of 160 to 220 hp., the plane achieved maximum speeds of 120 to 135 mph.

A slightly built lad of 18 when war broke out, Udet was rejected for military service at first, but soon became a dispatch rider at the front. In 1915, while on leave, he took lessons at a flying school and quickly won his pilot's license. Within a month, he was flying and fighting for the Kaiser.

ERNST UDET
..."Death flies faster"

Udet emerged from the war as Germany's greatest living ace — with 62 victories. Always an outstanding aerobatic artist, he revolutionized stunt flying and became a public idol as "The Flying Fool" in the '20s. In the next decade he helped develop the dive bombers and fighters that were to terrorize the world. He became a Colonel-General and Chief of the Technical Department of Hitler's Air Ministry.

Never a confirmed party member, Udet became a victim of Nazi intrigue. On November 18, 1941, it was announced he had suffered fatal injuries while testing a new weapon. But for the man who maintained that "Death flies faster," it was a bullet in the brain that brought death. Ernst Udet had killed himself.

Heritage of the Air

One of the most inspiring chapters in the history of technical evolution is the story of the men and flying machines of World War I. It is the highly personalized story of brave men — and the wood, wire, linen and rudimentary technologies that converted manpower to airpower. Today, Leach Corporation observes its 41st year in electronics with the presentation of this Heritage of the Air series.

* * *

Technical Director for Heritage of the Air is Lt. Col. Kimbrough S. Brown, USAF.

HAVE FACILITIES ...CAN DELIVER!

Promises, promises?

Certainly not. The greatly expanded production facilities of Leach Corporation make prompt delivery of relays for critical aerospace and electronic requirements a reality.

Actually, this year we've *doubled* our production capacity with new, ultra-modern facilities. This means Leach will continue to serve its present customers and will be able to meet growing demands from other industries.

Expansion is nothing new to Leach. Fortunately, we've always been faced with an exceptional demand for an exceptional line of products.

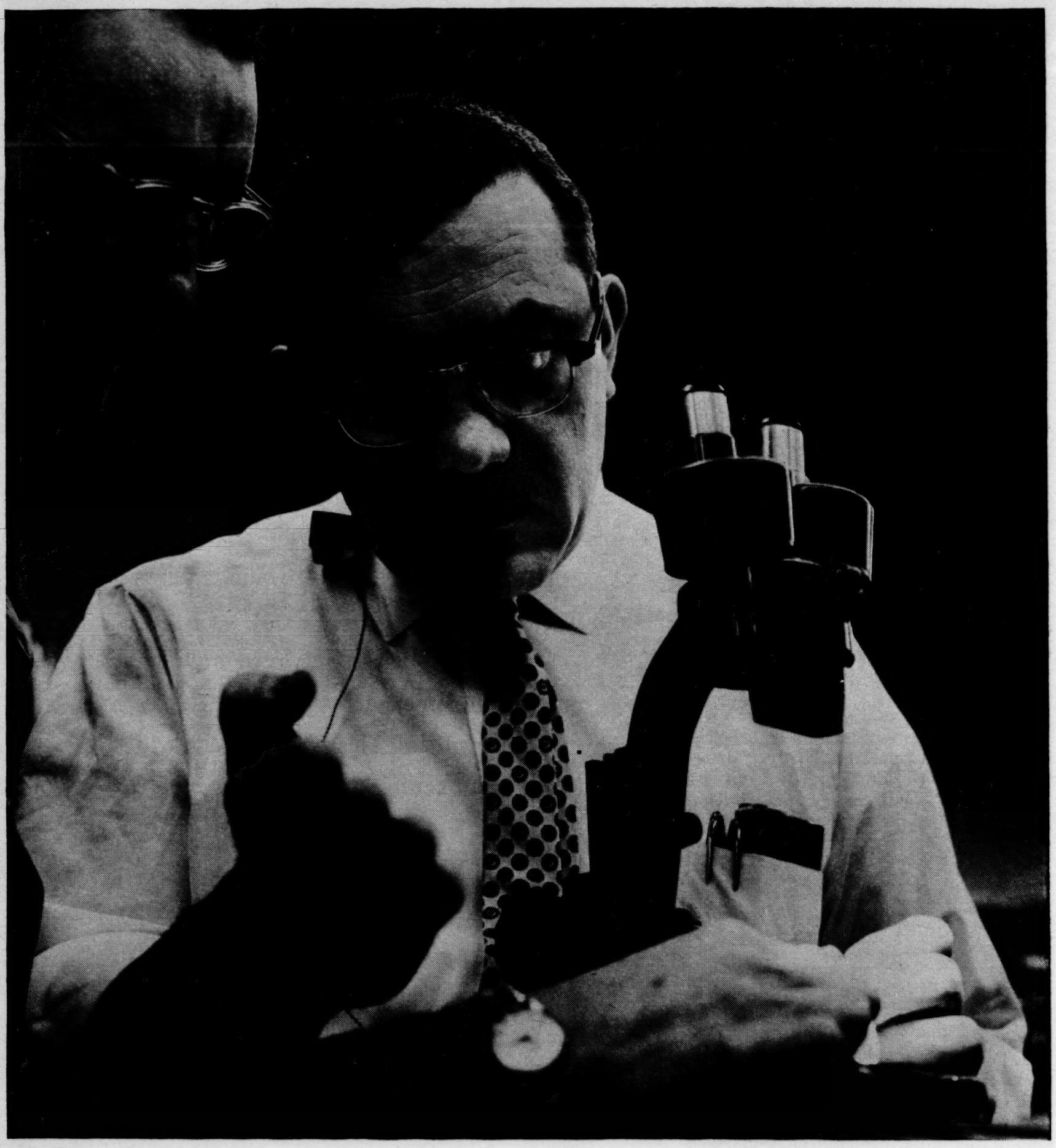
That's not bragging...that's stating a 41-year history of growth.

For power conversion systems, electronic subsystems and electromechanical components to meet the requirements of the space age...

LOOK TO LEACH

LEACH CORPORATION, 18435 Susana Road, Compton, California

EXPORT: LEACH INTERNATIONAL, S. A.



this is a man you should know... a Delavan fuel injection specialist

QUALITY PRODUCTION IS HIS RESPONSIBILITY

This is Bob Triplett making a point. And, you can be sure the fuel nozzle will be better because of it. Bob is Delavan's Plant Superintendent. His prime responsibility is maintaining Delavan's reputation as an excellent manufacturing operation. This means integrating Delavan's skilled personnel, precision machines and manufacturing techniques. Delavan mass produces thousands of reliable fuel injectors each year . . . at economical prices.

get to know Delavan fuel injection specialists

DELAVAN
Manufacturing Company
WEST DES MOINES, IOWA

Circle Number 226 on Reader-Service Card

Avionics Competitive Squeeze Tightens

By Philip J. Klass

"Avionics business will undergo a significant change during the next several years as a direct result of the current trend toward more complex weapon systems, procured in smaller quantities, and the needs of the nation's space program."

This forecast in AVIATION WEEK two years ago (AW Mar. 9, 1959, p. 213) could well serve with changes in verb tense to describe what is now taking place in this field.

From the standpoint of technological advances the industry is bullish and has every right to be. A fundamentally new development as the optical maser that a decade or two ago would have staggered the imagination of engineers and scientists is almost lost in a crowd of equally dramatic advances.

Despite indications that the percentage of Defense Department funds going into avionics and military electronics is increasing modestly each year, more companies are showing the economic pinch in their sales and profit figures for the year and quarter just completed.

The reason is plain: skyrocketing expansion of the avionics and military electronics industry has outstripped the expansion of the market. The impact has been heaviest on smaller companies, born during the past decade, which let their hopes and ambitions outrun their cash reserves. This has led to a spate of small-firm mergers and acquisitions, sometimes between companies suffering from the same disease.

Even the giants are feeling the effect, if not yet a pinch. One of the nation's largest military electronics manufacturers has cut back employment 15-20%, primarily in manufacturing. In one respect, the giants feel the pinch more than the smaller firms. They traditionally have depended upon profits from large-scale production contracts to underwrite losses or low profit margins on development programs. Many of the smaller firms have learned from their inception how to exist on development and small-scale production profit margins.

Two years ago AVIATION WEEK commented: "Low profit developments, which some companies accept in hope of recouping on subsequent large-scale production, will sap the industry's financial strength unless Defense Department revises the profit margin it allows on development and study programs."

To date, the Defense Department has given no indication that it recognizes the problem, or intends to allow higher profit margins on R&D work. Nor is it likely to do so unless it sees signs of real distress in the industry, and there are no such evidences yet.

In fact, industry's present eagerness for business is welcomed in most quarters of the Defense Department and Federal Aviation Agency, another major source of avionics business.

During a recent Navy competition to select a second-source producer for the Bullpup air-to-surface missile, approximately 50 companies submitted bids—the largest number ever to compete for a missile contract. Knowing that competition is going to be tough forces industry estimators to sharpen their pencils and pare their prices.

FAA Attitude

FAA's Bureau of Research and Development has taken a tough attitude in its contract negotiations as a result of the current oversupply of available contractors. In fact, some companies say that the FAA, and particularly BRD, is far tougher than any of the military departments.

Yet unlike the consumer products end of the electronics industry, where sagging sales and profits cause gloom to hang heavy at industry meetings, the avionics and military electronics end of the business is buoyed by the potential promise of new products and new techniques emerging from the laboratory. Not all of these hopes are realized, but disappointments are salved by still newer products and techniques which take their place.

Unquestionably the most significant industry wide development is in the field of microelectronics and molectronics, a subject engaging the attention of dozens of companies. (See p. 239.)

Another line of demarcation, whose fading began some years ago, has now been all but erased. This is the line which separates "aircraft manufacturers" from "electronics manufacturers." Within recent weeks practically the last holdouts among the aircraft firms, including McDonnell and Douglas, announced plans to expand their toehold in the avionics business.

Six years ago, when the first signs of this trend were first reported (AW Dec. 27, 1954, p. 42), there was concern and resentment by many avionics companies that had long worked with aircraft companies as partners who now saw them emerging as competitors.

Today avionics companies generally accept this competition gracefully, at least as gracefully as they accept competition from within their own ranks. In most of the satellite vehicle competitions held by the National Aeronautics and Space Administration, both are to be found among the bidders in roughly equal numbers.

Aircraft companies seeking diversification via the avionics field will find competition tougher, usually, than they have known in their original field of endeavor—both in terms of severity and numbers of competitors.

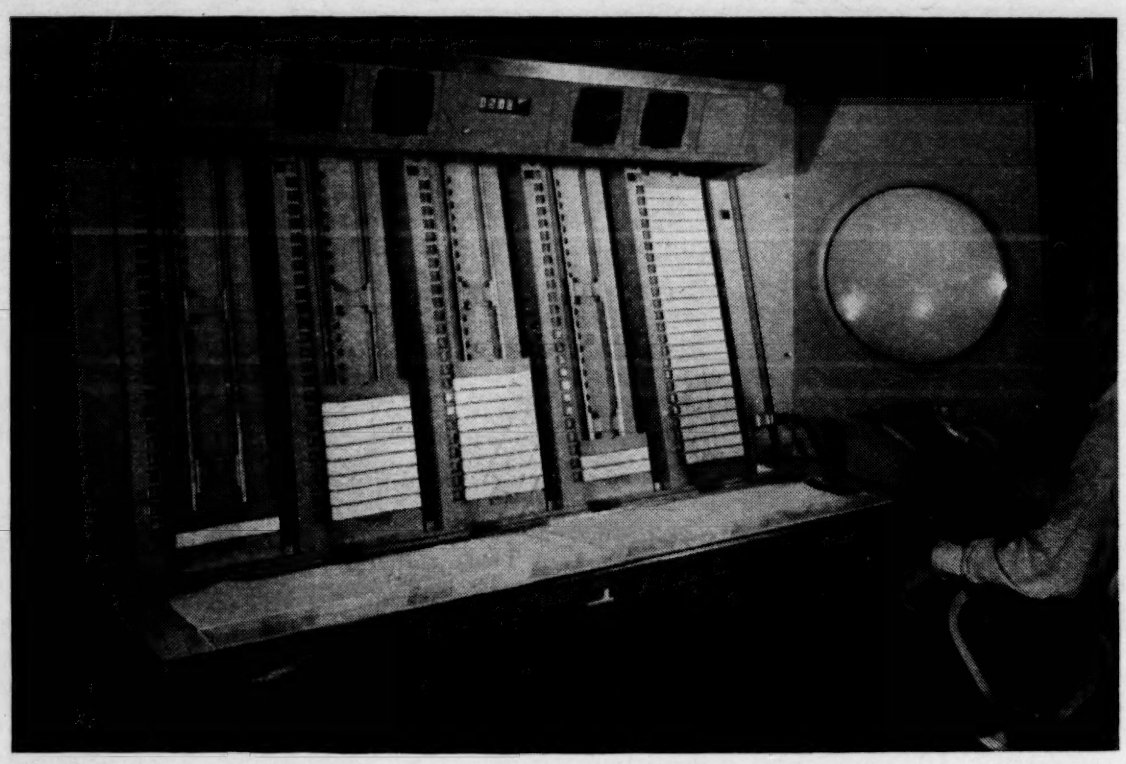
Observers believe that they will find it necessary to establish their avionics operations as autonomous corporate entities, as North American did with its Autonetics Division, to strip away needless corporate overhead and red tape and enable them to compete on more favorable terms.

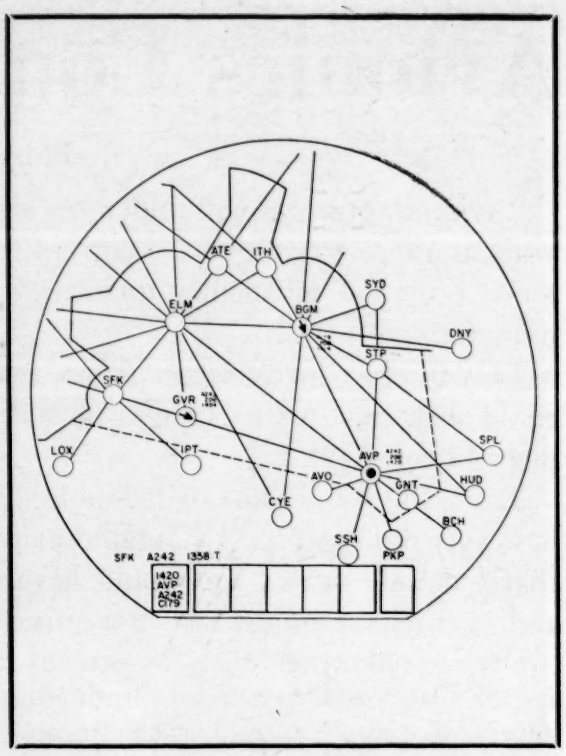
Possibly the greatest challenge to the avionics industry today is in the field of reliability. As the nation leans more heavily on ballistic missiles which can not be operationally exercised as completely as an aircraft, even with ground checkout equipment, the price of unreliability grows and can be measured in terms of the extra missiles and launch sites which must be built to assure the ability to place the required number on target if needed.

Recent experience with the AGREE test procedures (AW Jan. 23, p. 91) indicates that management has so many other pressing problems that it does not give sufficient attention to reliability unless forced to do so by rigorous proof tests which must be passed before the customer will take delivery and make payment. This suggests that the Defense Department will make increasing use of rigorous proof tests and probably will peg allowable contractor profit margins to the results of such tests.

But such tests in themselves do not improve reliability—they merely sort out the unreliable. To achieve significant improvement in reliability levels requires increased attention to the tiniest details in development, design and manufacturing.

This is the philosophy behind the Air Force's Minuteman program, where Autonetics as the guidance and control system contractor has set up an elaborate, and costly, program to improve the quality of all components and control their reliability levels in the vendors plants. (AW Dec. 12, p. 99.) If this program achieves improvement of several orders of magnitude in component reliability which is being sought, its impact will be felt throughout the avionics field.





EN ROUTE DEPARTURE/sector console for Federal Aviation Agency's new semi-automatic traffic control data processing and display system, to be tested this summer, provides automatic revision of flight progress strips by means of print heads (not visible) which move up and down vertical tabular displays under computer command. Potential traffic conflicts are predicted by computer and shown on Charactron tube at right. Sketch (right) shows typical display of conflict at fix AVP (Wilkes Barre) expected to result between two aircraft (arrows) as result of recent update of aircraft A242 at 13:58 when it reported over fix SFK. Using entry keyboard (under controller's hand), computer can be probed for possible solutions to eliminate conflict or predict others.

FAA Prepares to Test Modernized ATC

By Philip J. Klass

Atlantic City, N. J.—Within several months the Federal Aviation Agency will begin the first operational tests on its new experimental semi-automatic traffic control data processing and display system which is expected to provide the greatest single shot in the arm for air traffic control since the advent of radar.

Regular Region I traffic controllers will sit before new consoles and direct the flow of aircraft in a simulated New York and Boston environment while flight progress strips are automatically printed out, periodically updated automatically, and potential conflicts are displayed pictorially.

Practically all of the hardware for the system has now been delivered to the FAA's Bureau of Research and Development Center here and individual units are now undergoing debugging and familiarization tests.

Evaluation of the new system, developed by General Precision Inc., is only one of more than 100 research and development programs under way here, ranging from evaluation of techniques for improving existing facilities in the near future to programs whose impact may not be felt for five years or more.

Ambitious Program

The semi-automatic data processing system is the most ambitious and expensive equipment development program ever undertaken by the FAA, or its predecessor. It represents the boldest attempt to make basic improvements in a traffic control system which has changed relatively little since it was instituted three decades ago, when the aircraft using the nation's traffic control system numbered little more than 100, where today they are measured in thousands.

It also represents the first major attempt to relieve the traffic controller of the clerical workload which has grown through the years and which mushrooms during adverse weather and heavy traffic conditions—a time when he most needs to keep a clear head for cool judgment.

The elements of the data processing system now under test here reflect the basic modular, or building-block, philosophy under which the system had to be designed, unlike many industrial and military data processing systems.

This design philosophy reflects the fact that it is not possible to halt all air traffic, even in a small sector of the country, for an extended period to switch over to a new system. Furthermore, the new system had to permit easy transition from existing procedures to which both controllers and pilots are accustomed, and permit instant changeover to the old system in the event of equipment failure.

Another advantage of the building-block philosophy is that it permits early operational use of certain elements of the system without waiting for development and debugging of the complete system.

Ultimately the system is expected to provide the following functions:

- **Function 1:** Automatic flight plan processing and flight strip printing.
- **Function 2:** Automatic flight strip updating.
- **Function 3:** Automatic conflict prediction.
- **Function 4:** Bright tube radar display.
- **Function 5:** En route flow control.
- **Function 6:** Radar aircraft trackers.
- **Function 7:** Terminal area sequence control.
- **Function 8:** Radar beacon video processor.
- **Function 9:** Scramble-corridor and return-to-base computer, for military aircraft.
- **Function 10:** Analog type terminal area sequence control, for use at smaller airports.

To obtain various combinations of these functions usually involves the addition of another console, but in some cases it requires only the addition of a new program for an existing computer.

For example, the first installation of the new equipment is scheduled to go into the new Boston traffic control center early in 1962. It will consist of Functions 1 and 2, providing automatic analysis of flight plans, computation of ETAs at each fix, automatic printing of flight progress strips and updating of strips from subsequent pilot progress reports.

Established This Summer

As soon as the computer program for conflict prediction is established by operational tests this summer, automatic conflict prediction will be added.

The function-by-function modular design approach also allows FAA to test and evaluate the system operation and procedures on a step-by-step basis, instead of trying to debug the entire system. It also has the advantage of simplifying the transition problem for human controllers because new equipment can be introduced on a piecemeal basis.

The initial operational tests this summer at Atlantic City will evaluate Functions 1 and 2, with Function 3, conflict prediction, being added this fall to the evaluation tests.

As the Air Force learned from its experience with SAGE, FAA is finding that getting hardware is the easiest part of introducing automatic data processing equipment into a real-time control problem which involves human beings and machines and where the penalty for error is tragedy.

Computer Inflexibility

So long as human beings perform the control function, rules of the road can remain moderately flexible and difficult

FLIGHT PROGRESS strip holder shown being removed from console tabular bay, has punched holes along edge (arrow) which enable automatic print head to locate appropriate aircraft flight strip when commanded to update strip by computer.

problems can be worked out on a spur-of-the-moment basis without regard to normal procedures, if necessary. But when these control functions must be performed by a computer, which can not exercise judgment or improvise to meet a special situation, the procedural rules of the road must be clearly and unequivocally defined. For air traffic control, with its many variables, this poses a difficult computer programming problem.

Many of the procedural rules of air traffic control have grown like Topsy through the years and are only loosely defined. As both the military and industry have found when they have purchased computers, procedures which have grown up through the years often are not the most efficient way of handling the problem. If the full benefits of automatic data processing are to be realized, it is frequently necessary to modify existing procedures.

But with thousands of pilots and controllers accustomed to today's long-used procedures, FAA obviously does not have a free hand in altering them for datamation.

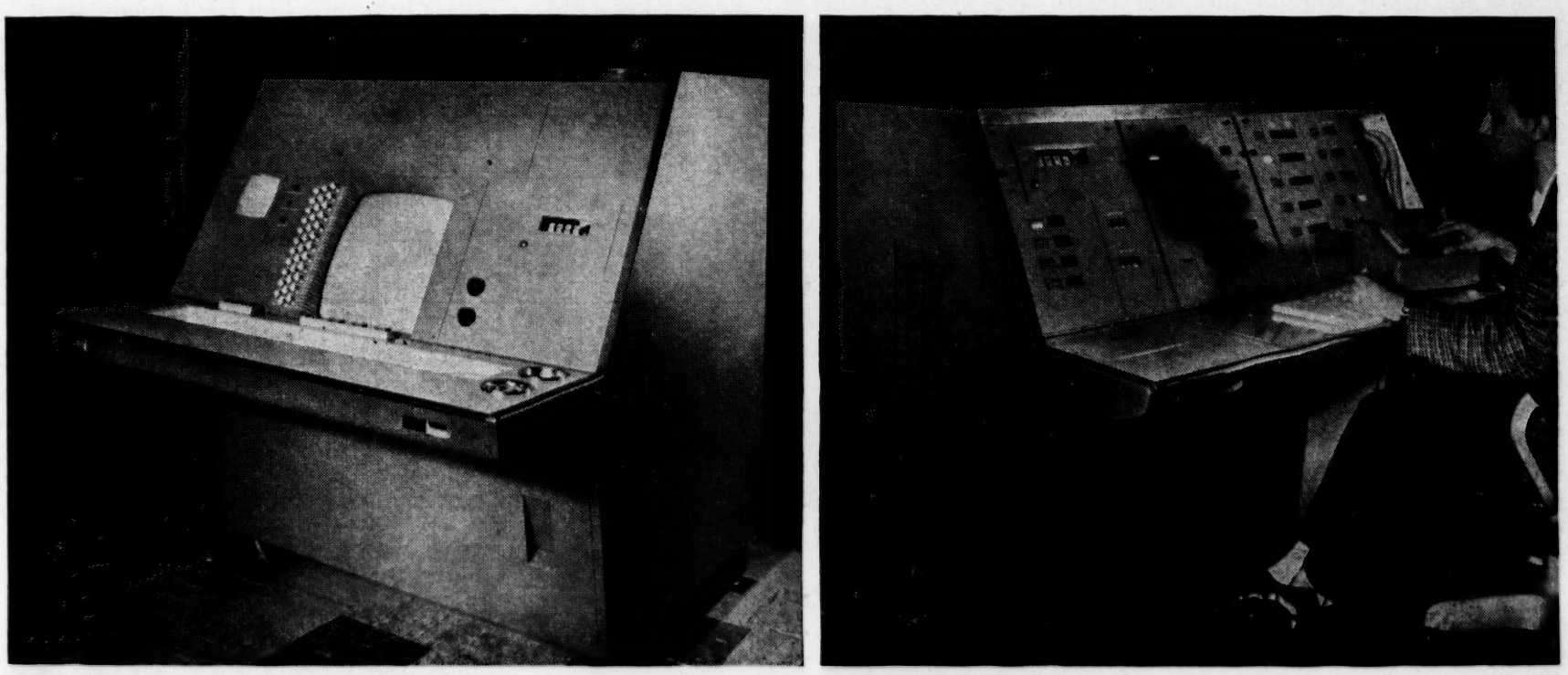
Transition Area

One significant operational change to be attempted with the new system is to push the terminal area holding stacks back from close proximity to the airport to a distance of 90-100 mi., and perhaps even to eliminate hold stackings altogether except under special conditions.

Today the terminal area stacks must be located near the airport to assure maximum utilization of the airport runways, so that when an airplane is cleared out of the stack for approach it is able to make its assigned time slot without likelihood of delay.

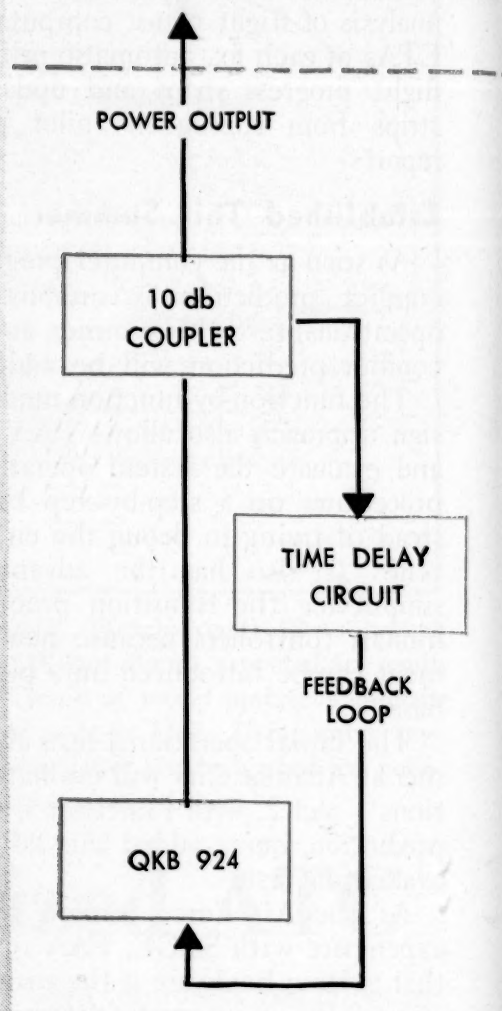
If the stacks were pushed out to 90 mi. using today's manual procedures, the approach controllers workload would be greatly increased because of the necessity of converting a stream of randomly arriving aircraft of different speeds into a steady flow of traffic into the airport. The controller would have the impossible task of trying to monitor each aircraft's position and speed while making mental calculations to try to work them all into a smooth-flowing stream.

With the new system, the terminal area computer will perform such compu-



SEQUENCE CONSOLE (left) will be used in terminal area traffic control to convert mass of randomly arriving aircraft into smooth flow and orderly sequence which will assure optimum use of airport facilities. Display tube shows aircraft in landing sequence and time ahead or behind schedule. Supervisor's console (right) for a multiairport terminal area shows number of aircraft expected to arrive at each airport for one-hour periods up to four hours in advance. System was developed by General Precision Inc.

QKB 924

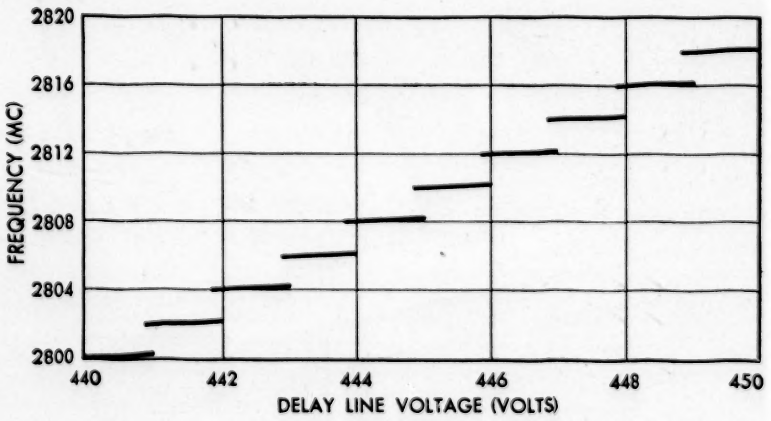


New Raytheon master oscillator assures extreme stability in frequency diversity transmitters

The QKB 924 voltage tunable "O" type backward wave oscillator with the feedback circuit shown above provides a highly stable master driver—local oscillator for S-Band MOPA chains.

External feedback through a delay line provides a 10:1 or more increase in frequency stability—performance that is particularly suitable for frequency diversity MTI applications. The frequency vs. voltage curve of the circuit is essentially flat at discrete steps over the entire 2,700 to 3,200 Mc range. Power output is typically 100 milliwatts with a delay line tuning voltage of 350 to 700 volts. Models are also available at frequencies through X-Band.

Write for detailed application information to Raytheon Company, Microwave & Power Tube Division, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario.



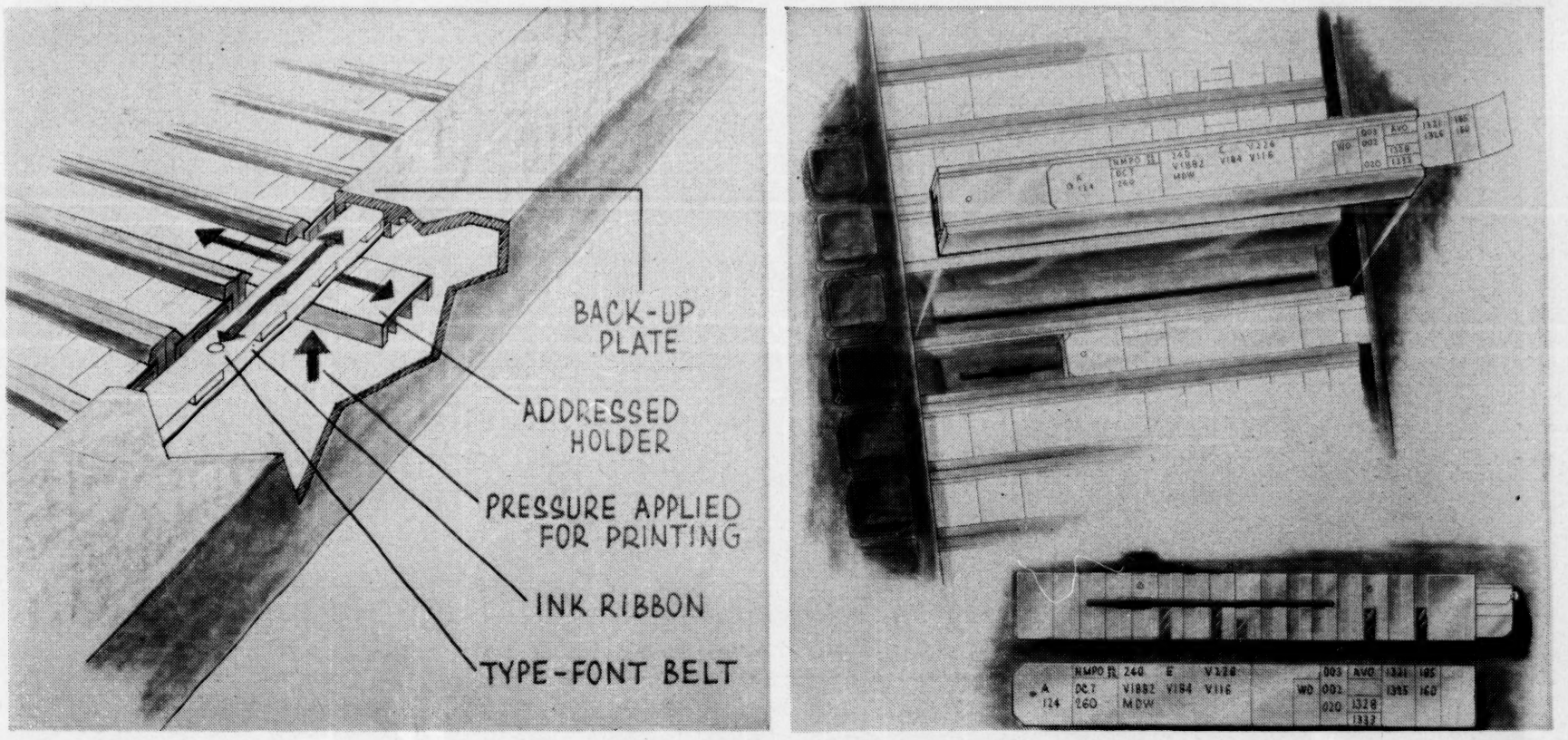
TYPICAL STABILIZED OPERATION

RAYTHEON COMPANY

RAYTHEON

MICROWAVE AND POWER TUBE DIVISION

BOSTON, MASS., BRowning 2-9600 • ENGLEWOOD CLIFFS, N. J., LOwell 7-4911 • BALTIMORE, MD., SOuthfield 1-0450 • CHICAGO, ILL., NAtional 5-4000
DAYTON, OHIO, BAldwin 3-8128 • LOS ANGELES, CALIF., PLymouth 7-3151 • CANADA: Waterloo, Ont., SHerwood 5-6831



NEW TYPE FLIGHT STRIP and automatic update printing mechanism eliminates problem of blocking controller's vision during update. Strip holder automatically slides to right and passes under revolving type-font belt which prints revised information on strip. Magnetic coding on strip holder replaces punched hole coding on strip used in earlier model.

tations in split seconds, providing the controller with a display that shows each aircraft's assigned landing time and how much it is ahead or behind its assigned slot.

As now envisioned, once the aircraft reaches the en route/terminal transition area, 90-100 mi. out from the airport, it will be cleared for a straight-in approach with no holding before landing, except under emergency conditions.

Controller Views

To assure that the data processing system and its operating procedures are acceptable to the men who ultimately will use them, FAA had a team of traffic controllers working with General Precision engineers during the development phase. Here at Atlantic City there is a team of 10 traffic controllers, soon to be expanded to 15, headed by A. S. Hall, Jr.

These men are drawn from traffic control centers around the country to assure that special geographic problems or situations receive full consideration. The men evaluate the displays and the ease of using data input devices in addition to overall system operation from a controller's viewpoint.

Judging from the reception that traffic controllers have given to the Univac computers installed at a handful of major centers, which compute fix ETAs and automatically print out flight progress strips, Hall believes that controllers will welcome the new equipment with its many additional features and capabilities.

Heart of the first installation scheduled for Boston in 1962 will be a digital computer built by Librascope, a division of General Precision. The data processor, as it is called, can store up to 1,000 flight plans on a magnetic drum, and can accommodate up to 16 drums (AW April 25, p. 105). The data processor for en route traffic control is expected to be identical in design to the one used for terminal area control, when subsequently added at Boston. This flexibility means that a single standby machine can be used as a backstop to either data processor in the event one fails.

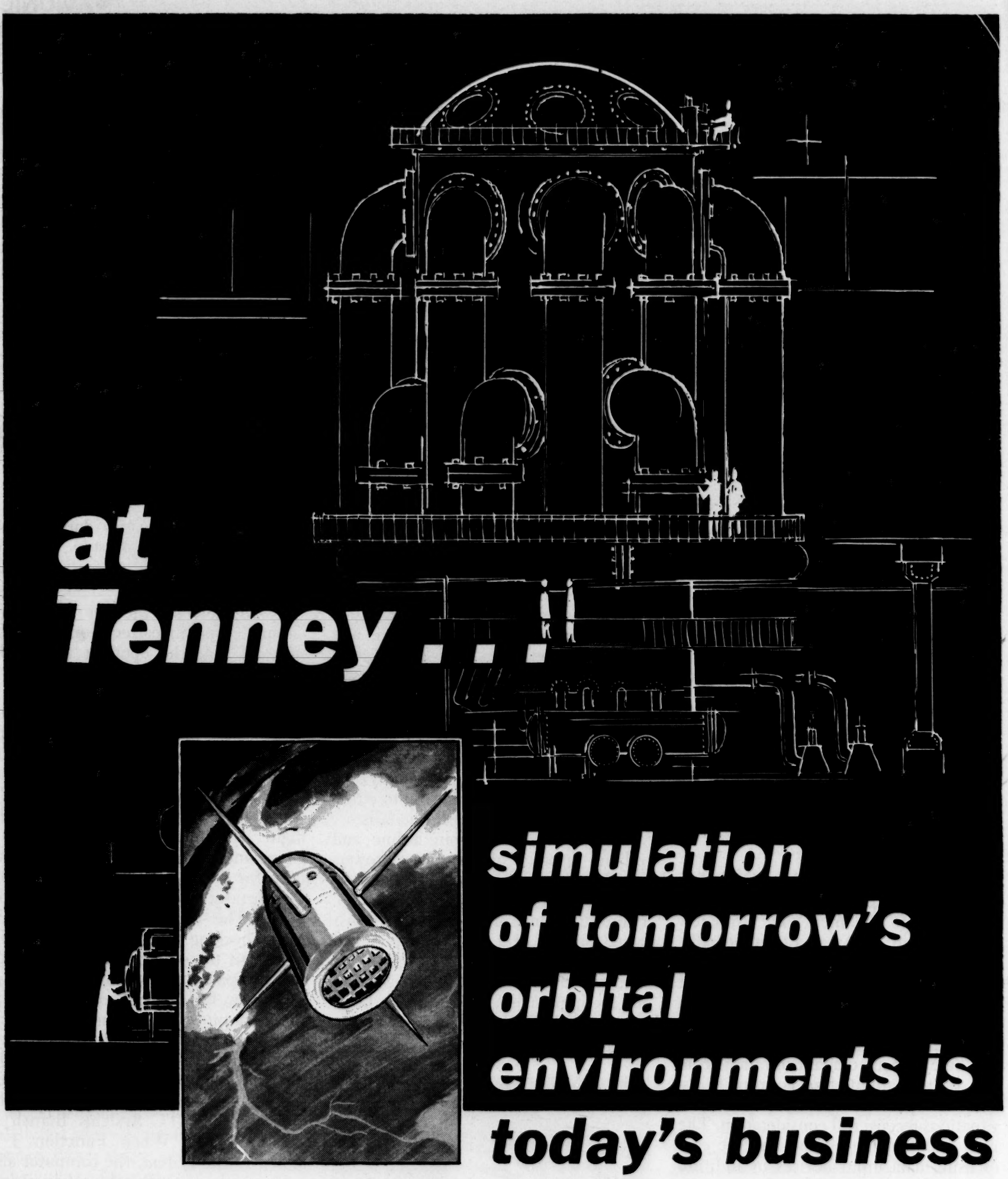
Flight plans filed from airline and military dispatch offices, airport towers or pilots in flight will be received by teletype or by voice, telephone or radio. Those that come in by teletype are first stored on one of a battery of punched tape machines that serve as temporary storage buffers and a hard copy is typed out for human inspection at the flight plan position in the traffic control center to be sure the message structure is complete and in correct computer format. If not, the operator revises the format or else asks the initiating office to file a revised flight plan.

DATA ENTRY keyboard is used by traffic controller to enter new aircraft information into the data processor and to probe possible solutions to a conflict situation.

Flight plans received by voice are prepared for entry into the data processor using a flight data entry equipment, known as Fliden, produced by Aeronutronic Division of Ford Motor Co. Fliden has a keyboard for composing the flight plan message in computer language and a character-type cathode ray tube for displaying the message before the operator releases it to the data processor. The machine contains built-in logic checking circuits which automatically alert the operator if the message is not composed properly.

As new flight plans are entered into the data processor, the machine calculates the aircraft's estimated time of arrival over the first two fixes, or for the next 30 min., whichever is the greater, according to Richard M. Scott, acting chief of the ATC Systems Branch at Atlantic City. When Function 3 is added to the system, the computer also will search through its other stored flight plans looking for potential conflicts with other aircraft for the next 30 min. or two fixes, whichever is greater.

Ten minutes before an aircraft's planned departure, the computer automatically transmits information to the punch/printer in the traffic control center which types out flight progress strips for the first two fixes or the next 30 min. A similar unit in the airport tower prepares a duplicate of the first flight progress strip for the flight data position, whose tabular display of progress strips is transmitted by closed-circuit



at Tenney . . .

simulation of tomorrow's orbital environments is today's business

Tenney's research and development in the field of orbital simulation and hyper environments has been bringing high altitudes down to earth throughout the Space Age. No other company can match Tenney's deep engineering facilities and its successful experience with America's most important aerospace projects. Write today for further information about **your** project!

Tenney
ENGINEERING, INC.

AEROSPACE DIVISION
1090 SPRINGFIELD ROAD, UNION, NEW JERSEY
PLANTS: UNION, N. J. AND WILMINGTON, N. C.

OLDEST AND LARGEST MANUFACTURER OF ENVIRONMENTAL EQUIPMENT

Circle Number 232 on Reader-Service Card

television to the tower's local control console.

The en route departure console, physically located in the traffic control center but functionally related to the airport tower's mission, has five vertical bays of flight progress strips, much like consoles now in use at traffic control centers. An important difference is that the new consoles contain provisions for automatic updating of progress strips, with the revisions printed instead of being scribbled in by hand as at present. The en route sector consoles, or peripheral consoles as they are sometimes called, will be identical to the en route departure console.

In the consoles now under test here, each progress strip, installed on an L-shaped holder, has punched-hole identification along the invisible leg of the strip which enables the data processor to correlate each strip with its respective aircraft's stored flight plan.

When a pilot calls in to report that he is over a fix at a time different from his ETA, the controller enters the new information into the data processor by means of an entry keyboard, a typewriter-size device that sits on the console, after having pushed the button opposite the appropriate flight progress strip to identify the aircraft involved.

Information Change

The data processor then computes new ETA's for the next two fixes and initiates instructions which cause a print head on the appropriate consoles to move up the vertical bay until it locates the appropriate aircraft progress strip by means of the punched hole code along the edge. The head then stops and crosses out the old information and prints the new ETA. Operation is similar when the aircraft is assigned a new altitude. The ETA can be updated three times in the space available on the progress strip, and altitude can be revised up to seven times.

Experience with the existing consoles has revealed an operational problem with the present design because the print head blots out the controller's view of several progress strips on the tab bay while it is updating a single strip. General Precision has therefore developed another design in which the printing mechanism is mounted on an endless tape along one edge of the bay and the individual progress strip holder is moved partially out of position automatically and under the moving tape for updating. In this design, the L-shaped punched-code progress strip can not be used. Instead, the aircraft identity is magnetically coded on the back of the strip holder itself. For this design, the progress strips would be automatically attached to the holder by machine to assure that the proper strip is installed on the appropriately identified holder.

FAA's decision to stick with flight progress strips instead of going to all-electronic type displays, is based both on the need for smooth transition from present techniques to the new equipment and the ability to revert to previous procedures in event of equipment or power failure. In the new system, controllers retain a printed display which can not be lost and which can be updated manually as in the past.

Conflict Detection

At an angle from the en route departure control is a conflict display, consisting of an 18-in. diameter Charactron cathode ray tube containing an overlay showing the air routes covered by the particular console.

When this function (3) becomes operational, an aircraft request for clearance received via the control tower will cause the data processor to search at the first en route fix along the proposed route for a clear time-altitude slot, based on the estimated time of departure and the particular climb-out characteristics of the aircraft involved.

If a conflict exists, the data processor will search for the nearest available time-altitude slot, either at a slightly later time or a different altitude, and display available alternatives to the en route departure traffic controller.

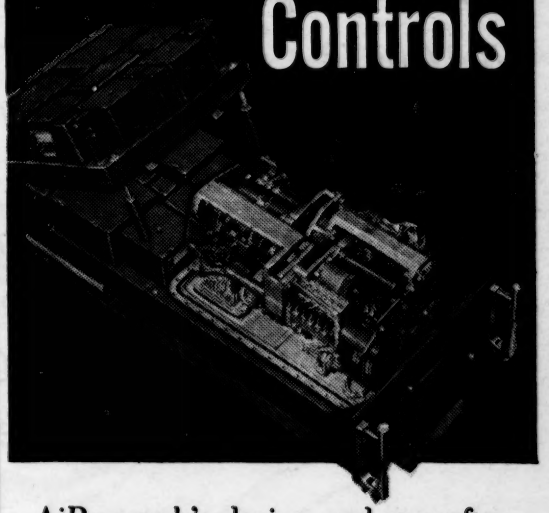
The controller then can select one of these, indicate his choice by means of the entry keyboard, and the data processor then will cause an update-clearance to be printed out on the tabular bay of the en route departure console and the flight data position in the airport tower.

The usefulness of the conflict prediction capability is even greater for en route aircraft. If the aircraft deviates appreciably from its ETA, as when it reports in late over a fix, and this information is entered by the controller into the data processor, the machine recomputes the airplane's ETA over the next two fixes and makes a conflict search. If it finds a conflict with one or more aircraft, the identity of the conflicting aircraft, the fix involved and the time of conflict is shown in one of five boxes at the bottom of the Charactron tube. Simultaneously, a red light flashes opposite the corresponding flight strip on the tabular display.

Normally the controller will push the button below the box which will cause the conflict situation to be displayed pictorially on the Charactron, along with information that shows what recent action produced the conflict, i.e. an update for ETA over a fix or a new altitude assignment.

To resolve the conflict, the controller can attempt a probing action, in effect

Automatic Sequencing Controls



AiResearch's design and manufacturing capability covers many types of automatic sequencing controls such as those for missile ground checkout, controlling drone and missile flight profiles, and automatic elevation and leveling of radar antennas and missiles.

Above is an AiResearch sequence controller for cabin temperature of a jet airliner. It assimilates 25 sensor element inputs and supplies command signals to 18 amplifier channels. Consisting of servo-operated potentiometer cards, cam switch programmer and other electromechanical components, it is another example of AiResearch's over-all ability to design and produce intricate and complicated servo systems.

The most experienced company in the development and production of control systems for airborne and ground use, AiResearch is an industry leader in electromechanical systems and components of all types for aircraft, ground handling, ordnance and missile systems.

OTHER ELECTROMECHANICAL COMPONENTS AND SYSTEMS

AC and DC Motors, Generators and Controls • Static Inverters and Converters • Linear and Rotary Actuators • Power Servos • Hoists • Temperature and Positioning Controls • Sensors • Programmers • Missile Launchers • Radar Positioners • Power Supplies • Williamsgrip Connectors

Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

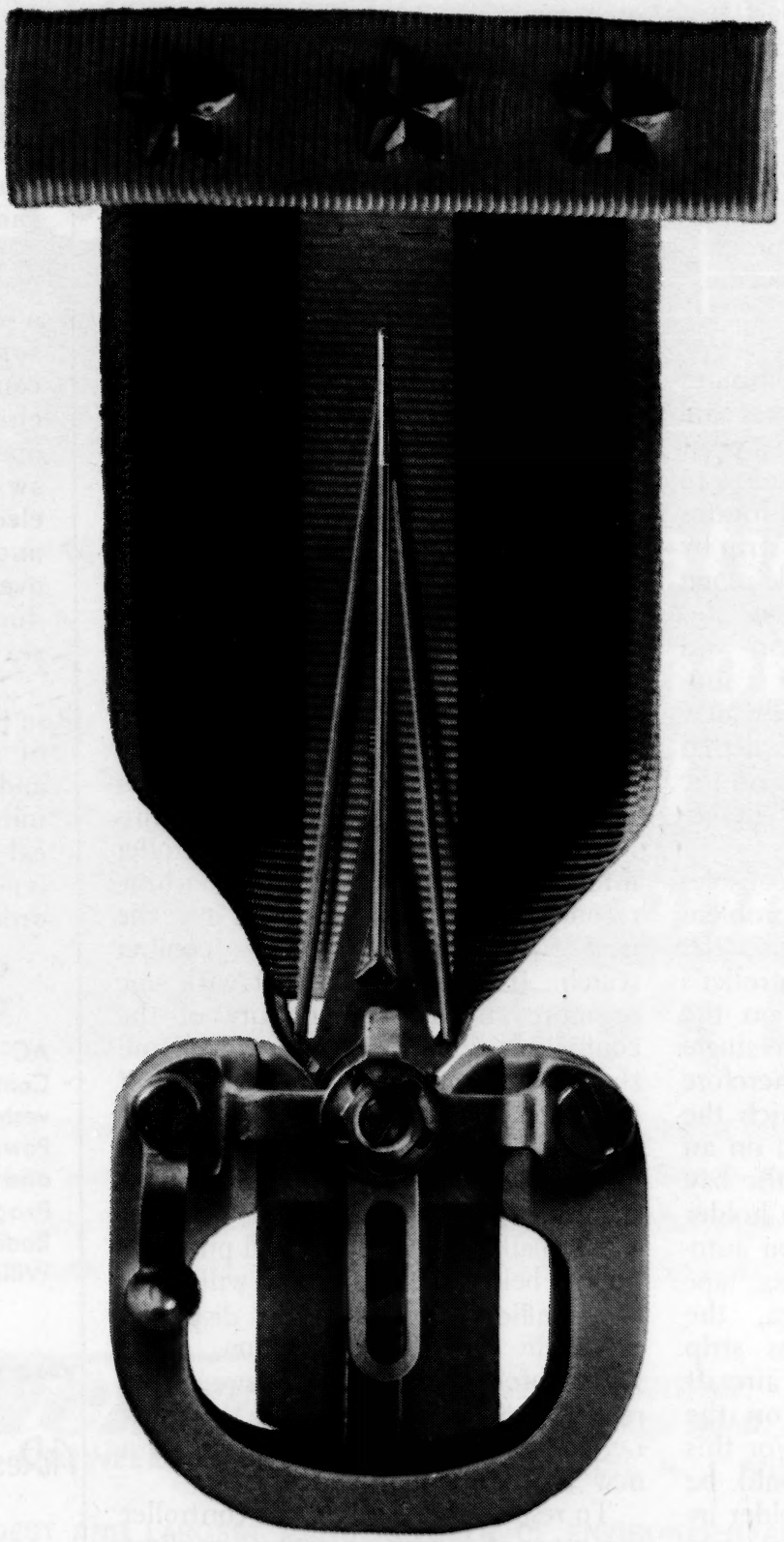
Circle Number 233 on Reader-Service Card

233

For distinguished service in the air — *Honeywell precision mechanisms . Imagination can't be kept on a shelf. That's why we offer no packaged panacea designed to solve all measuring and control problems. What we do have is the creative imagination of our designers and engineers. They can custom-make navigational or special-purpose indicators to solve any specific mechanism problems you may have . Let's talk over your needs and specifications. Just call our representative in your area. You'll find him in the classified section of your telephone directory. Or contact us directly: Honeywell Precision Meters, Minneapolis-Honeywell Regulator Company, Manchester, New Hampshire, U.S.A. In Canada, Honeywell Controls Limited, Toronto 17, Ontario . . . HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world.*

Honeywell

H HONEYWELL Precision Meters



Visit Our Booth—2202—at the IRE Show

Circle Number 234 on Reader-Service Card

asking the computer to advise him of the possible new conflict consequences of making a new altitude assignment to one of the two aircraft involved in the conflict. Using the entry keyboard and pushing the "Probe" key to let the data processor know that this is not a final decision, the controller can enter his proposed means of resolving the conflict.

If this corrective action will lead to other conflicts, the data processor flashes the new potential conflict data on the display, in which case the controller will try another possible solution probe, until the conflict is satisfactorily resolved without producing other conflicts. When this is accomplished, the words "No Conflict" will be displayed. The controller can now notify the aircraft of the required change, enter the revision into the data processor which in turn will update the airplane's flight progress strips on appropriate consoles in the center.

Arrival Test

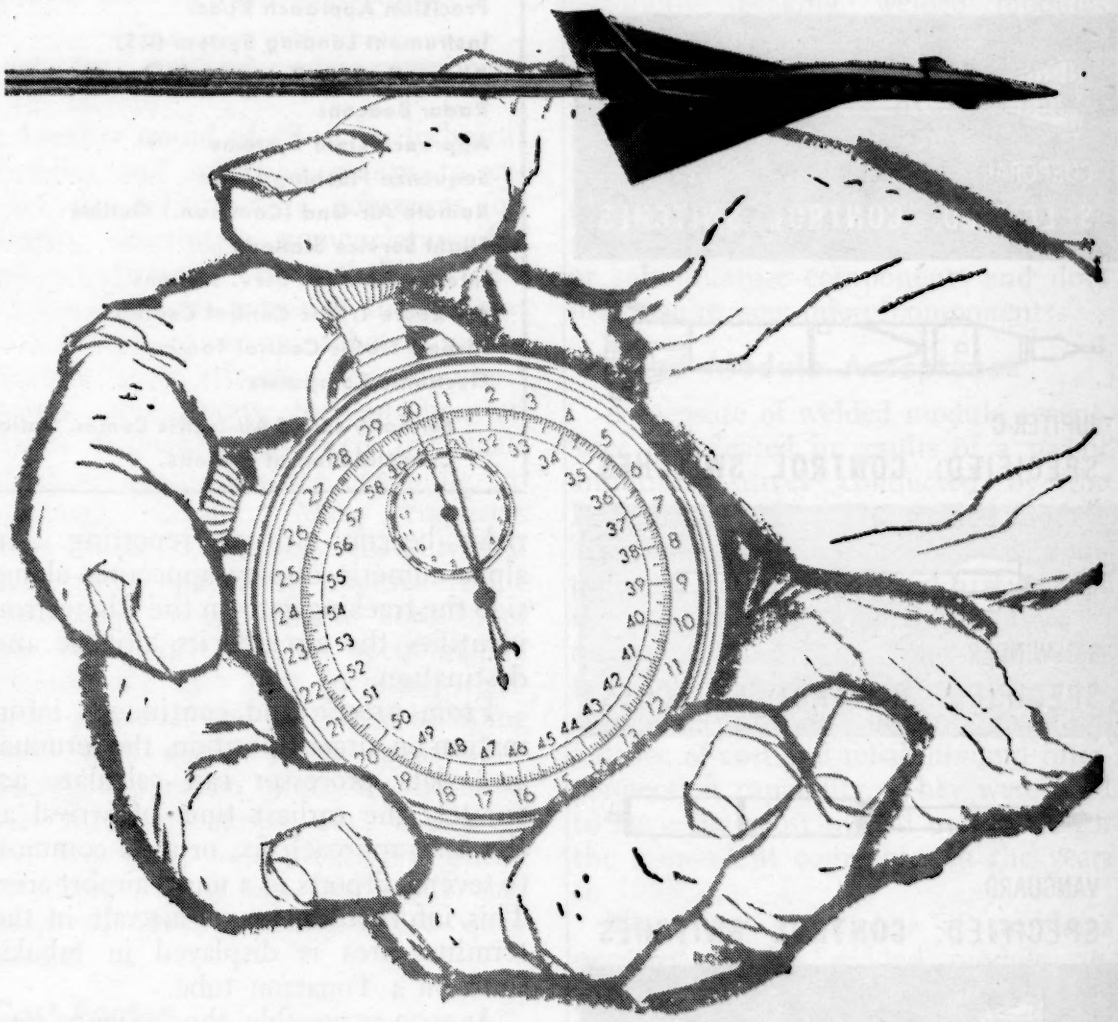
As an aircraft approaches the terminal transition area boundary, an acceptance probe is made in the terminal area data processor, located in the traffic control center, to determine whether traffic conditions will permit acceptance of the arriving aircraft. This probe is made on the basis of the aircraft's expected time of arrival at the transition area boundary; its earliest estimated time of landing, based on aircraft airspeed, local wind conditions and preferred aircraft descent profile, and the amount of time the aircraft could lose through path stretching maneuvers.

If a landing time slot is available which the incoming aircraft can meet, it is turned over to one of two controllers who man a transition sector console which contains a horizontal 21-in. Hughes Tonatron tube for radar display of aircraft in the terminal area. One of the controllers handles inbound traffic, the other outbound. The console includes two progress strip tabular displays for each controller with automatic update provisions, like those used in the en route departure and sector consoles described earlier.

If a landing time slot is available for the incoming aircraft, a square-shaped tracking gate will appear on the radar display near the fix or point where the airplane's radar target is expected to appear. When the aircraft radar blip arrives, the tracking gate is locked onto it. This causes a radar aircraft tracker, built by Tasker Instruments Corp., to measure continuously the aircraft's position and to determine its ground-track velocity. The radar tracking circuits are designed to operate in three-dimensions, looking forward to the time when information on aircraft altitude becomes available from height-finding radar or

How to Navigate at 2,000 m.p.h. Without an External Time Reference

Visit Us
IRE Show,
Booth Nos.
3038 & 3039



For a B-70 Bomber, operating independently of WWV or other ground-based communications, a primary timing system with a stability of 5 parts in 10^{10} per day had to be provided.

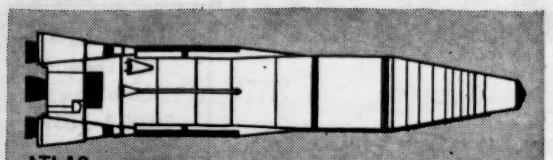
Hermes was selected by IBM as the sub-contractor to develop and supply the digital timing equipment for the AN/ASQ-28 (V) Bomber Navigation System. This System includes the Hermes 5mc Crystal-Controlled Oscillator. The entire Timing System is ruggedized to meet the stringent environmental conditions required by the B-70 Weapons System Program.

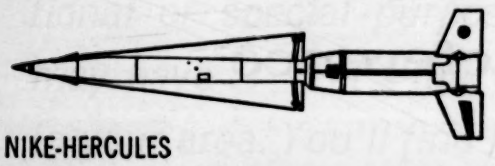
In the Digital Timing field, wherever the time dimension is critical, the complete and wide variety of engineering disciplines that can be provided by Hermes Electronics Co. are available for immediate action.

Write for Digital Timing Technical Bulletins

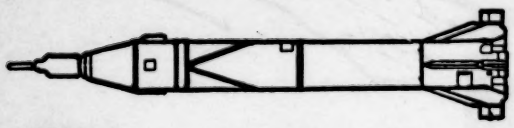
Hermes
ELECTRONICS CO.
75 CAMBRIDGE PARKWAY, CAMBRIDGE 42, MASS.
A DIVISION OF Itek

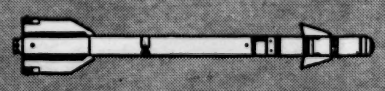
Circle Number 235 on Reader-Service Card


ATLAS
SPECIFIED: CONTROL SWITCHES

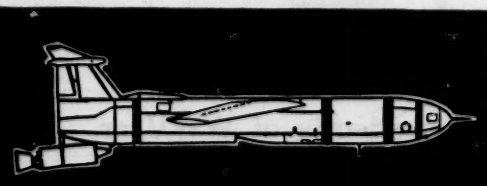

NIKE-HERCULES
SPECIFIED: CONTROL SWITCHES

CORPORAL
SPECIFIED: CONTROL SWITCHES

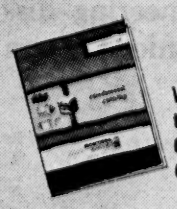

JUPITER-C
SPECIFIED: CONTROL SWITCHES


SIDEWINDER
SPECIFIED: CONTROL SWITCHES

VANGUARD
SPECIFIED: CONTROL SWITCHES


MATADOR
SPECIFIED: CONTROL SWITCHES

More and more successful aircraft and missiles are specified with switches and indicator lights made by Control Switch Division. Over 60,000 basic switch variations are available: sub-sub-miniature, sub-miniature, miniature, environment-free, hermetically sealed, multi-pole, and lighted push-button panel switches.


Write today for Condensed Catalog No. 100

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION
1402 Delmar Drive • Folcroft, Pennsylvania
TELEPHONE LUdlow 3-2100 • TWX SHRN-H-502

Circle Number 236 on Reader-Service Card

Status of Major FAA Facilities

	In Operation Jan. 1, 1961	Total Programed Thru FY '61	Additional Requested n FY '62 Budget
VHF Omniranges	725	789	71
VOR-Tacan Installations (VOR portion included in VHF Omnirange figures)	258	558	50
Enroute (long-range) Radar	41	82	2
Airport Surveillance Radar	52	84	0
Precision Approach Radar	18	24	0
Instrument Landing System (ILS)	191	250	16
Airport Surface Detection Radar	1	10	0
Radar Beacons	30	115	15
Approach Light Systems	125	174	36
Sequence Flashing Lights	86	174	36
Remote Air-Gnd (Commun.) Outlets	272	282	19
Flight Service Stations*	414	397**	−10
International Flt. Serv. Stations	11	10**	1
Air Route Traffic Control Centers	35	35	0
Airport Traffic Control Towers	228	280	0
Electronic Computers	6	6	0

* Formerly called Air Traffic Comm. Station, includes those combined with airport towers.
** Consolidation of stations.

radar beacon altitude reporting. An alpha-numeric display appearing alongside the tracking gate on the Charactron identifies the aircraft, its altitude and destination.

From precise and continuous information on aircraft position, the terminal area data processor can calculate accurately the earliest time of arrival at the final approach fix, or a fix common to several airports in a multi-airport area. This information for all aircraft in the terminal area is displayed in tabular form on a Tonatron tube.

As soon as possible, the sequence controller assigns an inbound aircraft to an available landing time slot, normally the earliest the aircraft can achieve.

The terminal area data processor then calculates the number of seconds which the aircraft must lose or gain to make good its assigned landing time. This information is displayed on the sequence console and at the transition sector console in the alpha-numeric display alongside the aircraft tracking gate, enabling the controller to relay instructions to the pilot to accelerate or path-stretch.

The terminal area data processor also reserves departure slots for outbound aircraft preparing to take off. However, in an emergency the sequence controller can commandeer a departure slot for an inbound aircraft.

The precision approach radar (PAR) console, operated by the approach controller, displays the next five aircraft due to arrive at the approach fix and their estimated arrival times. This console also contains a 21-in. Tonatron bright-display storage tube for showing the familiar azimuth-elevation position of aircraft in final approach, obtained from the PAR radar. PAR console was built by Tasker Instruments Corp.

The operation of the transition and terminal area part of the FAA's new semi-automatic traffic control data processing system, as described above, represents current thinking but is subject to modification if live real-time simulation tests here should point out the need for change.

The FAA program to develop and implement the new semi-automatic traffic control data processing system has slipped slightly from the agency's original timetable, which called for having the first production system in operation in the New York area early in 1963. (AW Sept. 30, 1957, p. 29.) Current plans calls for having a partial production system operational in Boston by late 1962, and a full system in operation in New York by early 1964. Despite an all-out effort by FAA's Bureau of Research and Development to assure that these dates are met, some observers believe that they may be optimistic.

General Precision's GPL Division, which was responsible for developing the system, has been criticized for both time and dollar overruns on the program by Bureau of Research and Development officials (AW Jan. 9, p. 30). In defense, GPL spokesmen point out that original FAA program objectives, of delivering an experimental system using existing equipment, were altered along the way by desires of both the FAA and the contractor to incorporate improvements and refinements not contemplated originally.

Circle Number 237 on Reader-Service Card→

Microelectronic Research Effort Grows

By Barry Miller

Over $100 million will be invested in microelectronic research and development during the current year as the needs of the nation's future missile and space programs for reliable, compact, low-power components and circuit functions become more crucial.

Almost every avionic component and systems manufacturer, as well as most of the major space frame manufacturers—Convair, Lockheed, Martin, Douglas and Boeing among them—are now studying and developing at least one of several possible approaches in the new field of microelectronics.

To keep ahead, or just abreast, of fast breaking developments in the technologies which sustain microelectronics, many companies are supporting several R&D programs in essentially competitive techniques. Each of these may provide useful avionic components and circuits for different but successive periods over the next 10 or more years.

Future Trends

During the year, several distinct trends will emerge in this field. These will include:

- **More proposal requests** for both prototype and flight hardware in which the military specifies that microelectronic techniques be employed.
- **Growing number** of small Army, Navy and Air Force supported basic research and development programs in microelectronics. In effect, these will initiate a much more fundamental, thoroughgoing approach to microelectronics than the Army and Air Force have followed by continuing support of programs in this field.
- **Greater demand** by design engineers for micro component reliability test data.
- **More extensive** use of a "pre" microelectronic approach—the welded module—in avionic subsystems of weapon systems.
- **Greater acceptance** of and desire for flexible and versatile packaging techniques capable of accommodating successive generations of microelectronic techniques and/or a mixture of microelectronic techniques.
- **Heavier demand** for and increased production of micro components. More avionic component manufacturers will introduce new micro component versions of commercially available, larger-sized components.
- **Continued efforts** to improve stability of thin film components, boosting capacity per unit area for film capacitors, and evaporating semiconductor devices.
- **More awareness** of the complexity of the problem of interconnecting microelectronic circuits with one another, with other subassemblies.
- **Concerted efforts** by systems designers to gain component manufacturers' support for standard micro-component form factors.
- **Another round** of effort by technical societies and scientific groups to extract an industry-wide consensus on simple, descriptive nomenclature for microelectronics. Nevertheless, new terminology will continue to blossom.

Although many approaches to microelectronics are attractive for important avionic applications, the unsupported claims frequently advanced in behalf of these approaches are becoming increasingly suspect. Many engineers want to see convincing reliability test data before embracing microelectronic techniques, though due to newness of the field too little has accumulated. Despite the fact that increased reliability potentially to be gained by doing away with solder joints, trouble-producing fabrication processes, unnecessary interconnections, etc., is one of the important motivations for microelectronics, it is on this point that most of these techniques are questioned.

Cost Factor

Comparative high costs of micro components or micro circuit functions are still prohibitive for many applications. Many microelectronic products —those beyond the development stages— are not available in production quantities, partly accounting for the high cost. These three factors—reliability, cost and availability—are obstacles to more general acceptance of microelectronics.

One early approach in the current effort to shrink avionic gear for missile/space applications is gaining wide acceptance. This is the so-called weldpack or welded module approach in which conventional miniature or subminiature components of assured quality level are mounted side-by-side, like railroad ties, in one of several structures. Component leads are welded together and usually the assembly is potted for environmental protection. Welded modules are available commercially from several companies including Raytheon, General Electric and Delco Radio.

The welded module technique is earmarked for avionic subsystems of several major weapon systems including:

- **Titan ICBM** (guidance systems).
- **Polaris** fleet ballistic missile (guidance computers).
- **Eagle** air-to-air missile (guidance computers).
- **Tartar, Redeye and Mauler** surface-to-air missiles (analog circuitry).

Strictly speaking, welded modules are not the products of microelectronics although they do achieve similar goals: large numbers of components in a given volume at reasonably high reliability levels. This approach to squeezing many components into a small reliable package uses miniature or subminiature components and does not require new micro components.

Welded Module Acceptance

A measure of welded module acceptance is reflected in results of a recent ambitious survey conducted by the P. R. Mallory Co. The welded module approach, including a soldered component counterpart, placed first or near the top on most graded responses to questions asked throughout the industry. The approach led in responses regarding inherent design flexibility, balance of cost and reliability and interconnection capability. They were held to have the most overall usefulness for the respondent companies in the years to 1965.

There are a number of problems peculiar to this welded module approach. One of these—and perhaps the one which may limit application of the technique in the next several years until more promising techniques mature—is the lack of components with uniform weld tolerances. If the module manufacturer must readjust welding procedures to accommodate components with leads made of widely varying materials, the cost of the process could become excessive.

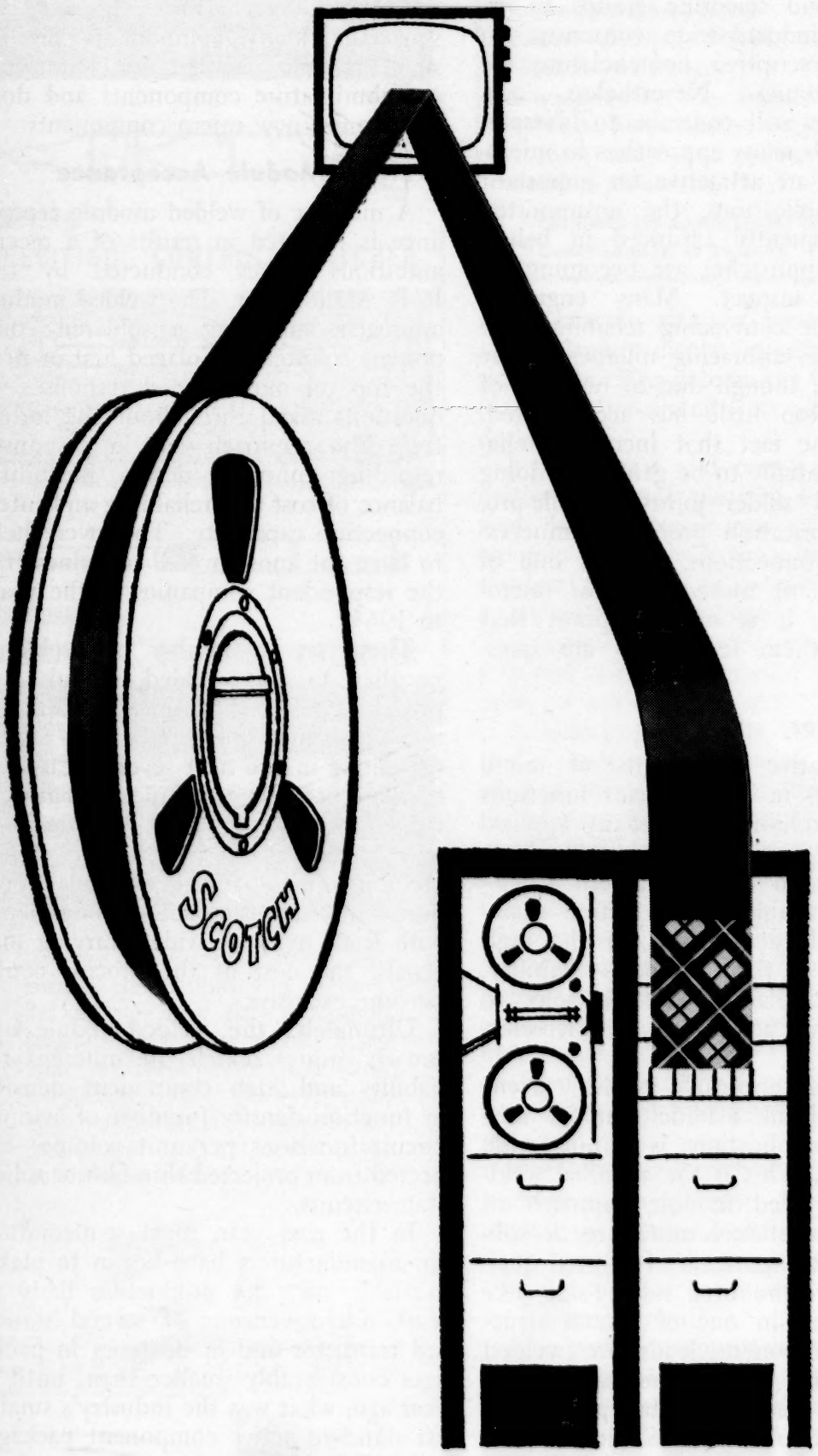
Ultimately, the welded-module approach cannot match the inherent reliability and high component density or function density (number of avionic circuit functions per unit volume) expected from projected thin-film or solid-state circuits.

In the past year, most semiconductor manufacturers have begun to make available—on pilot production basis at least—micro versions of several standard transistor and diode types in packages considerably smaller than, until a year ago, what was the industry's smallest standard active component package —the TO 18.

In the last several years the comparatively large size of transistors and diodes

THE TAPE THAT CHANGED TV FOR ALL TIME

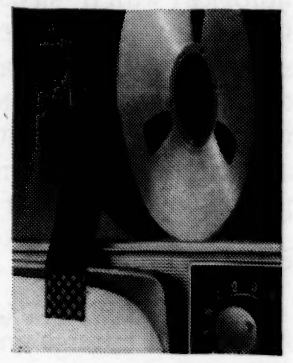
leads you right to rugged
SCOTCH® BRAND Heavy Duty Tape



THE TIE that binds television's top performer to instrumentation tape is strong—and it goes beyond the fact that the same expert team produces the best of both. "SCOTCH" BRAND Heavy Duty Tapes share a common heritage—and uncommon endurance—with "SCOTCH" BRAND Video Tape, the tape that puts a network TV show on the same "clock time" from Maine to California.

Similarities worth noting between the two: a similar high-temperature binder system, famous "SCOTCH" BRAND high potency oxides, a similar ability to resist tremendous speeds, pressures and temperatures while providing high resolution.

Let's look at the record of "SCOTCH" BRAND Video Tape and see what message it has for the user of instrumentation tape. On a standard reel of video tape like that shown here, some 1½ million pulses per second must be packed to the square inch—on a total surface area equal to the size of a tennis court. The tape must provide this kind of resolution while defeating the deteriorating effects of high speeds, pressure as high as 10,000 psi and temperatures up to 250°F.



The fact is that video tape must be essentially perfect. And it's a matter of record that thus far only the 3M experts have mastered the art of making commercial quantities of video tape that consistently meet the demands of the application.

Significantly, the high-temperature binder system developed for "SCOTCH" Video Tape is first cousin, only slightly removed, to that used in the Heavy Duty Tapes. It's this special feature that has given Heavy Duty Tapes their exceptional wear life.

The moral emerges: for tape that provides the best resolution of high and low frequencies under the severest conditions, turn to "SCOTCH" BRAND Heavy Duty Tapes 198 and 199.

They offer the high temperature binder system, plus the same high quality and uniformity that distinguish all "SCOTCH" BRAND Tapes. As the most experienced tape-makers in the field, 3M research and manufacturing experts offer tape of highest uniformity—from reel to reel and within the reel. Check into the other "SCOTCH" BRAND constructions: High Resolution Tapes 158, 159 and 201; High Output Tape 128; Sandwich Tapes 188 and 189; and Standard Tapes 108 and 109.

Your 3M Representative is close at hand in all major cities. For more information, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

© 1961 3M Co.

"SCOTCH" and the Plaid Design are registered trademarks of the 3M Company, St. Paul 6, Minn. Export: 99 Park Avenue, New York, N.Y. Canada: London, Ontario.

REG U.S. PAT. OFF.
SCOTCH BRAND MAGNETIC TAPE
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

Circle Number 240 on Reader-Service Card

was the barrier to further miniaturization of individual components. Since the transistor had reached a minimum size, reductions in the size of passive components did not provide significant volume savings. Interestingly, introduction of the transistor 12 years ago was an impetus for current microminiaturization efforts. In succeeding years, passive components—resistors, capacitors and coils—had to be shrunk in size to be made compatible with and to realize the full space and power savings of the smaller transistors. Before long many of these components were made smaller than transistors—a situation that remained until the appearance in the past year of micro transistors. These were made possible by packaging and sealing techniques which permitted a reduction in the large, useless volume within a standard transistor can.

Until now, industry purchases of micro components have been largely in experimental quantities. Recently, however, component companies report sales of larger quantities—enough in some cases to justify tooling for production quantities. At least one component maker, Pacific Semiconductors, on the basis of growing demand, is tooled to make up to 20,000 micro diodes and transistors a week.

Micro Applications

What to do with micro components once they are available is another problem. They are finding application in microcircuits and in a variety of systems packaging plans, largely on a developmental basis. Yet the tiny devices need careful handling and are difficult to keep track of and difficult to work with unless requisite skills are acquired.

Partly to satisfy this need, a number of component makers have begun to prepackage numbers of components into single larger units for specific uses within given circuits. These multiple units—called special assemblies—using subminiature and miniature components are being offered by a growing number of firms. Typically, one such assembly might consist of four identical diodes (called matched quad) in a bridge configuration packaged as a single unit and suitable for use on a printed circuit board.

Some component makers, such as Mallory, are offering customers a packaging service which will prepackage micro components in circuits meeting the customers' specifications. There are a variety of other multiple component or multiple semiconductor junction packages being offered.

By and large, the demand for micro components was generated by systems engineers and by new concepts of packaging components into assemblies for

Skilled Technicians
Using Advanced Machines
Now Bring You
Long-life . . High-Reliability

RECTILINEAR POTENTIOMETERS

Potentiometers made by California General have these improved characteristics:

- Resistance welded connections . . . eliminating failures due to soft solder contaminating material at connections.
- Only one screw fastener used in unit . . . with no hidden screws to loosen under vibration.
- Minimum number of parts . . . eliminating alignment difficulties and adding to rigidity of construction.
- Molded plastic parts . . . bringing greater dimensional stability and closer tolerances . . . insuring identical dimensions of each part.
- Glass Mandrels . . . eliminating possibility of insulation breakdown plus improved linearity and resolution.
- Lighter brush pressures . . . increasing useful life and reducing possibility of electrical noise.

PR 1 series available with electrical travel from ½" to 5". . . resistance of 50 ohms per inch to 20,000 ohms per inch.

California General designs and fabricates to your specifications.

New techniques and machines enable California General to fabricate potentiometers in large or small quantities for less money . . . resulting in lower costs to you.

California General can deliver potentiometers in quantity within days . . . instead of weeks.

For further information . . .

Telephone Mr. D. C. Baker, GArfield 2-5349 or write . . . California General Inc., 798 F Street, Chula Vista, Calif., within Metropolitan San Diego.

CALIFORNIA GENERAL, INC.

798 F Street, Chula Vista, Calif.

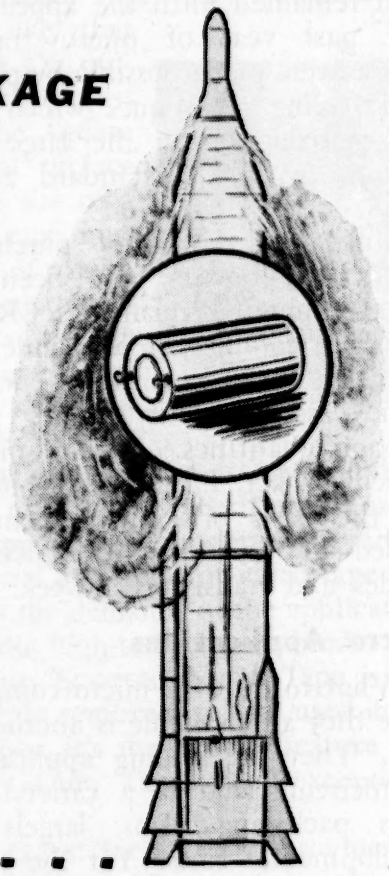
Circle Number 241 on Reader-Service Card

9876543210

NORTRONICS
A Division of
NORTHROP CORPORATION

NOW

A COUNT-DOWN CHECK OF THE GYRO PACKAGE



IN ONLY 3 SECONDS . . . . . .

For the first time, a complete check of the guidance package can be accomplished with the missile in firing attitude. Another first from Nortronics-Norwood, this new self-testing rate gyro, is a major break-through in checking a missile control system for in-flight dependability. From only two leads, utilizing the gyro's ac signal and putting in dc current, the integrity of all circuitry between the excitation source and the gyro can be determined.

In only three seconds pre-checks can be made of motor synchronization, gimbal freedom, signal generator, or dynamic characteristics. Furthermore, this can be done with a precision exceeding that of most laboratory instruments. This new self test gyro can endure extreme environmental conditions on a continuous or intermittent basis. It will withstand shock to 500 g's. Designated as the GR-H4-T, it is slated to maintain in-flight stability on Polaris, Bomarc, Atlas, Nike-Zeus and many other current missile programs.

A companion product now under development using the same components is an integrating gyro of the same size. Requiring no heaters, this gyro stands ready from -65°F to +200°F. Write us for further information.

PRECISION PRODUCTS DEPARTMENT, NORWOOD, MASSACHUSETTS

Field Offices: Highway #46, Teterboro, New Jersey, Telephone: ATlas 8-1750, TWX-Hasbrouck Heights 871-U
2486 Huntington Drive, San Marino, California, Telephone: ATlantic 7-0461, TWX-Alhambra 9619-U

Circle Number 242 on Reader-Service Card

use in avionic systems. Most of the packaging concepts involve substrates of varying sizes in or on which components are mounted. Usually the substrates, as in approaches of Radio Corp. of America, Burroughs and Sylvania, have fixed dimensions. In others, Hughes, Mallory and Thompson Ramo Wooldridge, substrate size is more flexible. Circuits or components are interconnected with other substrates in many fashions.

Too frequently, promising parts density figures, computed on the basis of the number of components which occupy a given substrate, cannot be realized because of the excessive volume occupied by interconnecting wires or because the interconnection problem cannot be solved. Most packaging programs are now devoting considerable attention to effectively solving this difficulty.

Packaging programs—especially the RCA Micromodule program which has had $15 million of Army funding—stimulated extensive component developments aimed at repackaging available component types or developing new components in the Micromodule micro element format. As a result of RCA or Army funding, a number of micro components evolved and are now available commercially.

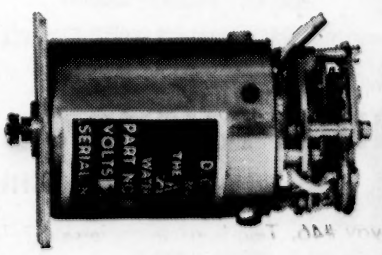
Because the micro components were developed to satisfy needs of a particular packaging program or were developed as a natural next step in the evolution toward smaller parts, micro components are available in a multiplicity of formats. Transistors, for example, have different shaped cans—some tall, others short, with axial or planar leads, some already set into the distinctive 0.3 in square Micromodule wafer. Passive components can be obtained in similar shapes. Some like those made by Erie Resistor, Mallory and Microelectron are in pill box shapes suitable for use in the perforated packaging boards of the Thompson Ramo Wooldridge and Hughes programs.

Fearful that too few components will be available in compatible sizes or suitable for automated assembly of large space/missile system, a group of systems engineers has organized a Subcommittee on Microminiature Components of the Electronic Industries Assn. The engineers hope to agree on a uniform set of formats for semiconductor and non-semiconductor components and then persuade component manufacturers to hold their designs within these formats. This would assure systems people of multiple sources for critical parts. Ultimately, this group feels, standards in line with these recommended designs would be adopted.

Component makers have had mixed

A
tLAS
HAWK
TITAN
DISCOVERER
SPARROW
THOR
SNARK
TIROS
FALCON
CORVUS
NIKE HERCULES
TALOS
PIONEER
SIDEWINDER

TIME TO TRAVEL... in a bird, or elsewhere, this A. W. Haydon timing motor is unique. We married our successful Vanguard II sub-miniature DC motor, for power, to a tiny new version of our well known (and patented) chronometric governor, for precision. Result: it will drive miniature tape recorders, printed circuit commutators, potentiometers, and such things... and hold its speed to within ±0.1% of the speed you want, even if the shaft load, line voltage and ambient temperature vary widely. It weighs a mere two ounces and measures less than 1¾" x 15/16", yet delivers at least 30 ounce-inches of torque at 1 rpm. For full information on this #14600 motor, or any other sort of timing device, electronic or motor driven, just write.



THE AWHAYDON COMPANY
222 NORTH ELM STREET, WATERBURY, CONNECTICUT

Circle Number 243 on Reader-Service Card

Five units comprise the Bendix repeater to relay messages in the UHF band between ground stations and aircraft.

THE FIRST UHF REAL-TIME ACTIVE SATELLITE REPEATER, designed for one year of continuous operation in orbit, has been developed and fabricated by Bendix Systems Division under sponsorship by the Wright Air Development Division of the United States Air Force in conjunction with an ARPA program. This development typifies programs offering new career opportunities to better engineers and scientists.

BENDIX SYSTEMS DIVISION
ANN ARBOR, MICHIGAN

THE Bendix CORPORATION

Circle Number 244 on Reader-Service Card

reactions to the subcommittee's efforts. Some complied with the first requested recommendations and began turning out components to satisfy them. Others believe it is too early for the industry to think seriously of standards.

Speculating about the needs of future avionic systems and recognizing the fast rate of change in microelectronic techniques, many systems engineers feel that the best microelectronic system packaging approach is one with growth potential. A single approach which best satisfies the needs of an actual system might differ from the one selected as most appropriate when the system is only in the study requirement stage. A packaging approach flexible enough to accommodate a mixture of successive generations of techniques is strongly favored. It is interesting that RCA engineers working on the company's Micromodule program and speaking at technical meetings in the past year have stressed the Micromodule's ability to handle different techniques or a mixture of techniques.

Thin films of both active and passive elements eventually should prove one of the most attractive microelectronic techniques. Advantages of thin film would include reduction of potentially faulty interconnections, good resistance to radiation, extremely high density of components, low power consumption and ease of fabrication.

Thin passive films deposited on an inert substrate with micro transistors or uncased transistors as active elements inserted into holes drilled in the substrate or cemented to the substrate are in development at several dozen laboratories. As yet, the industry has not yet mastered the techniques for depositing active components on the same dielectric substrate. This may require new substrate materials which will have the same crystal structure as the semiconductor but retain good dielectric properties for passive circuitry.

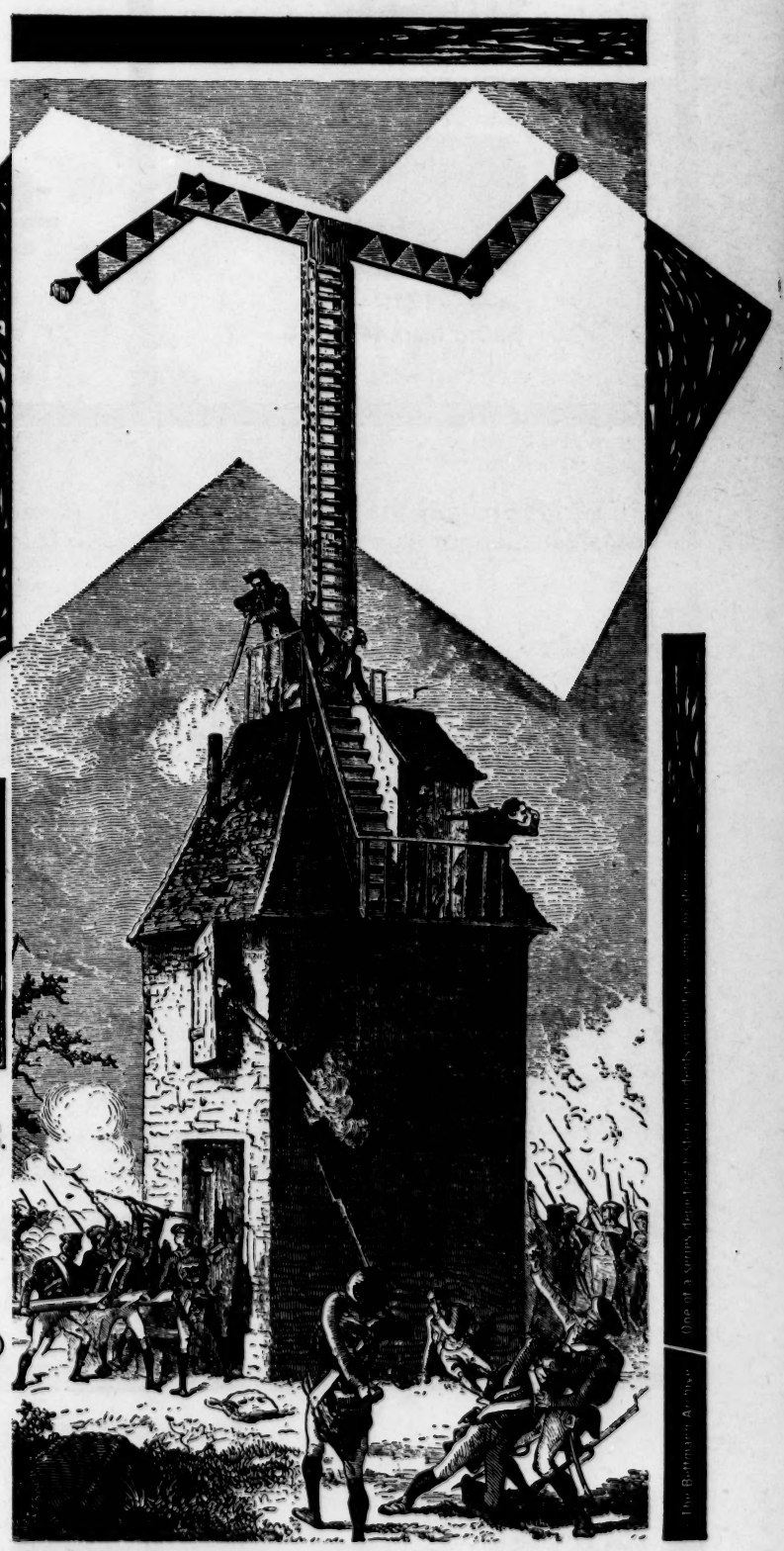
During the last several months the number of requests for proposals from all three military agencies—Army, Navy and Air Force—for small scale research and development efforts in microelectronics has been on the increase. These requests cover such work as thin film and epitaxial film growth, connection and interconnection of functional circuits, batch and continuous deposition of thin films.

Besides the research contracts, the requirement that microelectronics be used in both prototype and actual hardware for military avionic equipment appears more frequently in proposal work statements. These often cover computer and control subsystems and other systems such as physiological monitoring packages—which by their nature are only possible with a high degree of microminiaturization.

LONG RANGE INPUT / 1794

News of the recapture of Condé from the Austrians was sped to the French Revolutionary Convention at Paris in a matter of minutes via Claude Chappe's amazing télégraphe aérienne, or relay aerial telegraph, Sept. 1, 1794. A new era in rapid communications had begun.

Today, instantaneous and completely reliable Electronic Communications insure the immediate and continuous interchange of intelligence throughout the Free World. ECI is proud of its initiative and responsibilities in the design, development and manufacture of high precision electronic equipment to the critical specifications required in various aerospace and surface roles vital to our National Defense and to scientific achievement. An example is ALRI—Airborne Long Range Input—a program where ECI communications and data link equipment fill an integral and essential requirement in linking USAF's advanced early warning system to SAGE—our continental defense network.



System Development
Communications
Data Link
Countermeasures
Computers
Actuators

ELECTRONIC COMMUNICATIONS, INC.
St. Petersburg, Florida

RESEARCH DIVISION
Timonium (Baltimore), Maryland

ADVANCED TECHNOLOGY CORPORATION (ADTEC)
Santa Barbara, California

REGIONAL OFFICES: Washington, D.C., Teterboro, N.J., Boston, Mass., Dayton, O., Dallas, Tex., No. Hollywood, Calif.

CIRCLE 245 ON READER SERVICE CARD 245

Oster®

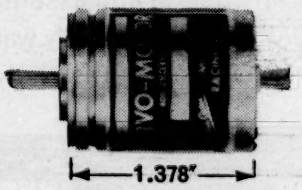
new size 11 servo motor

For 400 Cycle Airborne & Ground Control Applications

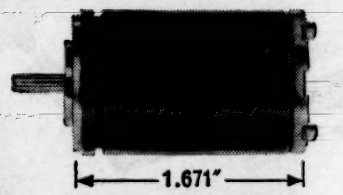
IMMEDIATE ★ FROM STOCK ★ DELIVERY

1

SHORTER than Mark 14 Mod 0



NEW TYPE 5104-01



BuOrd Mark 14 Mod 0

2

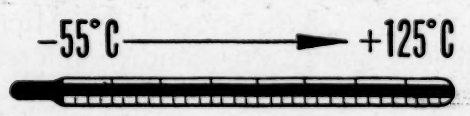
LIGHTER than Mark 14 Mod 0

NEW TYPE 5104-01

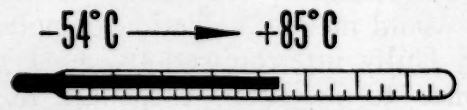
BuOrd Mark 14 Mod 0

3

HIGHER TEMP than Mark 14 Mod 0



NEW TYPE 5104-01



BuOrd Mark 14 Mod 0

4

BETTER FINISH than Mark 14 Mod 0—Tests show that New Type 5104-01's passivated bright finish resists corrosion at least as effectively as black oxide.

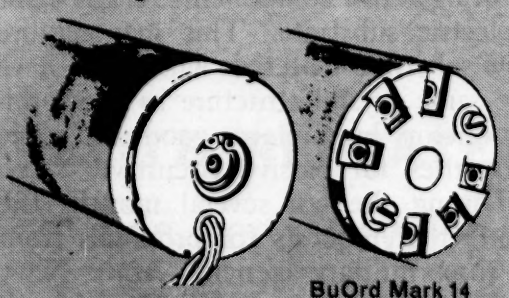
New Type 5104-01 has the same electrical characteristics as Mark 14 Mod 0	EXCITATION FREQUENCY	ROTOR INERTIA	TIME CONSTANT	MAX. STARTING VOLTAGE
	400 cps	1.07 gm.cm.^{2}	15.6 ms	2.6%

	FIXED PHASE	CONTROL PHASE
Input Current	53 ma	53/106 ma
Input Voltage	115V	115/57.5V
Power at Stall	3.5W	3.5W
Resistance (R) at Stall	1250 Ohms	1250/312 Ohms
Reactance (X) at Stall	1780 Ohms	1780/445 Ohms
Impedance (Z) at Stall	2175 Ohms	2175/544 Ohms
Effective Resistance (R) at Stall	3800 Ohms	3800/950 Ohms
Nominal Capacity for Unity PF	0.16 mfd.	0.16/0.64 mfd.

Meets ARP 497. Stainless steel housing used.

5

HIGHER RELIABILITY at LOWER COST than Mark 14 Mod 0—Achieved by eliminating terminal board arrangement and utilizing lead wires.



NEW TYPE 5104-01

BuOrd Mark 14 Mod 0

For your higher reliability, advance design requirements in rotating components, contact your nearest John Oster office.

John Oster MANUFACTURING COMPANY/ Specialists in Instrumentation and Display/ Avionic Division: Racine, Wisconsin

Servos
Synchros
Resolvers
Motor Tachs
Computers
Indicators
Servo Mechanisms
DC Motors

EASTERN OFFICE

310 Northern Blvd.
Great Neck, Long Island, N.Y.
Phone: HUnter 7-9030
TWX Great Neck, N.Y. 2980

WESTERN OFFICE

5333 South Sepulveda Blvd.
Culver City, California
Phone: EXmont 1-5742
UPton 0-1194
TWX S. MON. 7671

Engineers For Advanced Projects: Interesting varied work on designing transistor circuits and servo mechanisms. Contact Mr. Dallas Nielsen, Personnel Manager, in confidence.

Circle Number 246 on Reader-Service Card

Missions Expand for Vertical Flight

By David A. Anderton

Three major factors are shaping the future of vertical-lift modes of flight:
• New military mission requirements which cannot be efficiently performed by conventional vehicles now in the inventory.
• Opening of new land areas for industrial or population growth in regions not served by the usual transportation networks.
• Changing transportation needs of massive metropolitan areas such as New York, Chicago and Los Angeles.

The first two factors are providing the incentive for invention and design of unique vehicles to solve unique problems. The third factor is providing the incentive to develop these unique solutions in general applications for economical transportation.

Changing Pattern

Together they will work tremendous changes on the pattern of world-wide movements of passengers, payloads and platoons. If the first half of this century has become known for the development of powered flight, so may the second half become known for the development of vertical flight.

Exploitation of the modes of vertical flight started with the helicopter, whose rotating wings provide even today the only really efficient way of lifting payloads vertically off the ground. Twenty years of helicopter development have produced a contemporary flying vehicle that has proven its worth in variety of military and civilian roles.

In recent years the helicopter has seen its lead in vertical lift challenged by two different types of aircraft. First among these was the short-takeoff-and-landing (STOL) aircraft which, with a little engineering effort, has been turned into a vertical-takeoff-and-landing (VTOL) type.

This kind of aircraft, although it hovers well, does so very inefficiently from an economical standpoint. Its real virtue lies in its ability to combine hovering capability with high cruise velocities well beyond those attainable by today's fastest helicopters.

GEM Machines

Second newcomer to the vertical travel field was the air-cushion vehicle (ACV) or ground-effect machine (GEM). These strange hybrids of surface vehicle and aircraft are borne over the earth on a layer of air, drawn in generally from above the craft and blown out in a uniform layer underneath. Thickness of this layer varies with the application. It may be only a fraction of an inch or it may be measured in feet. GEMs, like their VTOL relatives, do not hover efficiently. But their particular virtues are in doing a truly amphibious job or in operating over any kind of mixed terrain where no other single vehicle could travel.

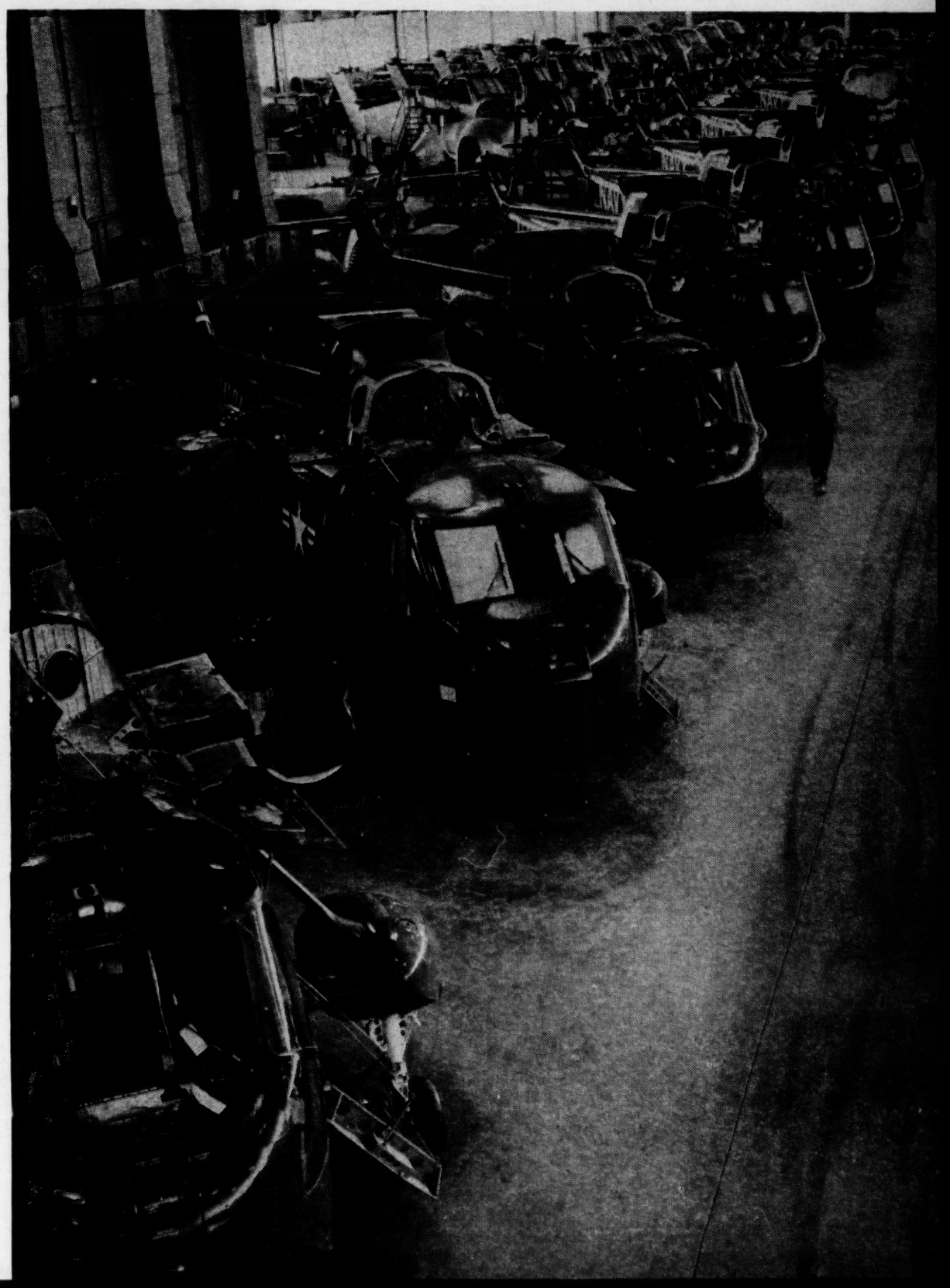
In times past, these categories of vertical-lift devices have been fairly easy to separate. Helicopters worked; VTOLs and GEMs didn't, at least not very efficiently.

Helicopters were in large production, doing jobs for their military and civilian owners. VTOL vehicles were few in number, and were making halting and short flights, ignominously tied to the ground, or making their first tentative ventures into the free air. GEMs were nothing more than overgrown toys, built to prove a principle.

But the rate of technical progress, which rides an exponential curve, worked in favor of the newcomers. Their progress has been so rapid that now they must be grouped together with the helicopter as possible solutions to any problem of vertical flight.

New Requirements

Newest of these problems are spelled out in a group of three unrelated military mission requirements, which actually have much in common. Just a few



SIKORSKY HSS-2 production line. Line of S-58s is in background.

BELL HUL-1M powered by Allison T63 turbine engine made its first flight in December (AW Jan. 2, p. 19). Bell Hu-1 is overhead.

years ago, these missions would only have been considered in terms of their solution by helicopter. Today, they are calling for three different types of vehicles.

These three seem destined to stand in the future as turning points in the development of vertical-lift aircraft:

• **Army light observation helicopter** (LOH) design competition, aimed at an eventual production order for several thousand rotary-wing aircraft. Army's requirement is built around a well-developed concept of flight which in the past has been retarded by high initial costs and maintenance charges. This first really large production order for helicopters—if it materializes—should see development of a rugged, simple, maintainable helicopter whose technical features could feed back into other future types.

• **Tri-service transport competition,** financing the development and construction of a service-test quantity of VTOL logistic transports. Designs are expected to be in the 35,000-lb. category, with payload capability estimated between 6,000 and 16,000 lb. depending on the choice of either the VTOL or STOL mode of operation. Range is reported at 500 naut. mi., and cruise speed is expected to be in excess of 275 kt. This competition is planned to get a state-of-the-art machine into service test so that the major problems and advantages of the unique mode of VTOL flight can then be determined.

• **Logistics over the shore** (LOTS) mission, a joint Navy and Marine Corps requirement for a resupply vehicle, may kick off development of the first large, practical, military ground-effect machines. This requirement, stemming from the appalling losses of conventional amphibious vehicles during beach assaults in war and maneuvers in peace, calls for operation to beachheads from a far-offshore fleet. With a 150-naut. mi. radius of action, and operated at high speeds, such GEMS could carry payloads on the order of 10 to 12 tons in a 45,000-lb. gross weight vehicle. The major advantage of the GEM—its true amphibious capability—would show to advantage in this mission. There would be no problem of rough water near the beach, rollers or waves off-shore, mines or obstacles in the water. Troops would arrive on the sand, not yards off-shore in neck-deep water.

New Lands

Just as new military needs are sponsoring development of new kinds of airborne vehicles, so will the unique needs of land exploration open new avenues of approach for vertical-lift designs.

The potential of vertical flight in the exploration and opening of new territory has been only partially realized. There are still hundreds of thousands of square miles that are too far from the nearest available helicopter base, the nearest railhead, the nearest docks or fuel storage depot. Even today's sophisticated helicopters capable of doing the Navy's stringent antisubmarine mission —one hour's cruise, two hours' hover and one hour's cruise—can't perform all the jobs that active engineering minds can dream up.

One solution is offered by the combined capability of all three of these forms of vertical flight.

The proposal starts with a mobile base which is an enormous GEM, capable of movement over land or water or mixed terrain. This base carries at least one crane helicopter in its payload, plus the other necessities of life at a remote point.

The base could move up to the headwaters of a river, or across miles of tundra or marshland and drop anchor in an open area big enough to contain its dimensions plus some space for maneuvering. From its deck the helicopter could fly deep over jungles, let down a pod of workmen to clear an area, drag away the trees and brush, and then land in the clearing. It could ferry more men, temporary buildings, mobile equipment and supplies to that base while the original helicopter landing area was being expended to a small landing strip.

At this point, heavy ferrying could be taken over by a V/STOL transport which could operate from the jungle

strip to the deck of the GEM if necessary, or to an adjacent strip cleared in the same way. The availability of a short-distance runway increases the load-carrying capability of the V/STOL transport tremendously, and it becomes the prime mover of heavy loads in this three-vehicle combination.

This is just one example of how the unique mission capability of each type of vehicle can be integrated into an overall delivery or supply system which is much more efficient than any one type, working alone, could be.

With the entire Middle Atlantic seaboard on the verge of becoming a contiguous metropolis several hundred miles long, the need for efficient transportation increases many-fold. Conventional means are no longer solutions to the problem. The highways are clogged and cannot be built fast enough to keep up with the use-growth rate of vehicular traffic. Rail service is deteriorating. Long-distance air transport crowds the airways in metropolitan areas and threatens to be the controlling factor on all movements of all air traffic along the eastern seaboard.

Is there a solution? Proponents of the helicopter say there is. Their suggestion: the large high-speed helicopter.

The helicopter shows great promise today as an airborne hoister of objects. It can carry payloads externally or internally, lift them, lower them or drag them if necessary. It can tow boats, pull trucks out of the axle-deep mud, and lay telephone or power lines.

This versatility has had its price in high initial and maintenance costs. But development programs now on the horizon for the helicopter are aimed at decreasing these factors and at the same time improving its efficiency as a transport.

This means, of course, getting the direct operating costs down to the point where they are better than fixed-wing aircraft. Some current analyses show that the crossover point now occurs somewhere around 30 to 50 naut. mi. Technical improvements will raise that point to perhaps 100 naut. mi., or a region where intercity transportation by helicopter will become not just a desirable and expensive luxury, but a useful and economic necessity.

Some airline managements now would concede the very short haul market—New York to Philadelphia, for example—to existing turbine powered helicopters if adequate city-center heliports were available. As turbine helicopter speeds increase, perhaps with the addition of stub wings, they feel conventional transport aircraft will be easily outdistanced up to 200-300 mi. stages.

At the moment, the only uncluttered avenues of approach to any metropolis are the low-altitude airlanes, the regions where helicopters can operate. Future intercity transportation will use these open highways, at first for conventional helicopters, then later for compounded helicopters or V/STOL transports.

Here again a combination of the three types of vertical-lift aircraft may prove a solution. Air-cushion vehicles have been seriously studied for operation overland, their lightweight bodies riding a restraining rail. With such equipment replacing the ancient combinations of commuter train, bus and ferry, the high-density traffic of the peak hours could be moved rapidly and efficiently.

Business and pleasure traffic between points three hours' drive apart could be handled by either helicopter or V/STOL transport. Long-range intercity travel could become province of the helicopter or its developed derivatives.

Pace of Progress

Each of these three types of vehicles had its own limitations as well as its best application. But the development curve for all three types has risen so rapidly that—as in the case of the airplane—it is not easy to extrapolate that curve to find out where it is going. All that can be said is that the curve is going up at a rate faster than the visionaries dreamed or the planners expected. The missions that looked impossible for the helicopter five years ago are being done today. The jobs that are considered now as limiting for the VTOL aircraft may be routine and primitive tomorrow. The GEM's field, restricted now by consent to where it has no competition, may be a major area of transportation in the future.

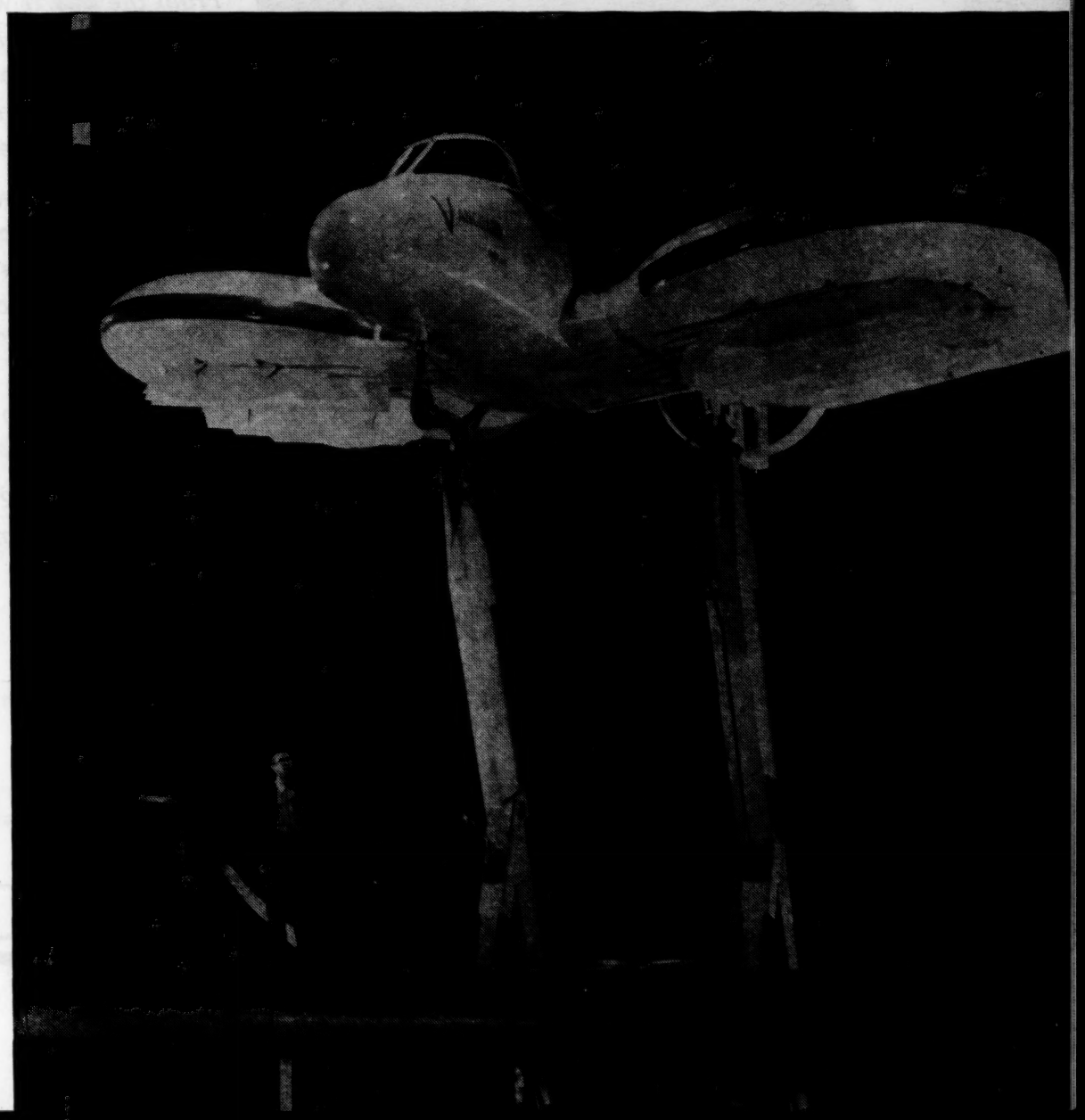
No Growth Parallel

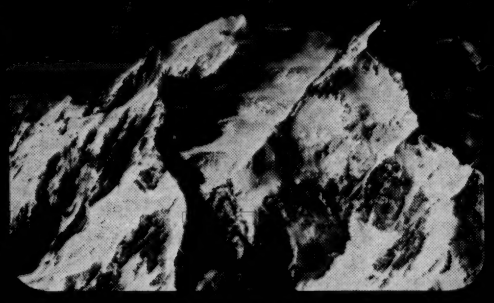
There is no parallel for the remarkable growth rate of these new categories of aircraft. The airplane, which has lived through an explosive growth pattern, has been around for about 60 years. It has spent almost half of its life maturing to the point where it could be considered as a legitimate means of transportation. It took about 30 years of engineering development before the airplane could become an efficient vehicle, carrying a sizable payload at speeds of 200 mph. for costs that approached the competition.

In contrast, the helicopter as a practical flying machine has been on the aeronautical scene only about 20 years. Within its first decade it was flying military missions that no other vehicle could tackle. Now at the threshold of its second decade, it is beginning to show competitive price structure for short-haul transportation.

Faster still has been the rate of progress with VTOL aircraft. Five years ago these were aeronautical

VANGUARD Model 2D ducted fan VTOL vehicle built by Vanguard Air & Marine Corp. is tested in NASA's Ames Research Center wind tunnel at Moffett Field, Calif.





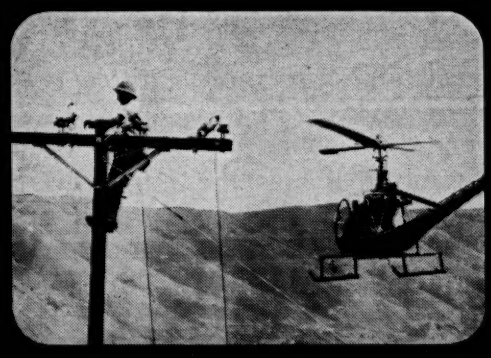
Hiller 12 E sets aviation record, lands and picks up payload at 18,000 ft.

12 E, first light copter to erect entire powerline; 40′ poles, el. 5,000 ft.

34,500 lbs. of machinery to exploration mine in 8 hrs. mountain flying.

Microwave station on 4,000′ ridge; all 8 tons material; 2 days flying.

You are invited to write for full details.



2½ mile powerline built in 6 hrs., 50 mins. with E's 305 hp at work.

El. 10,000 ft. Two 12 E's fly 80 gal. sprayloads; 60 flights in 4 hrs.

THE ARMY GROWS 'EM TOUGH

How the Hiller 12 E Became First Choice of Commercial Operators

From the day it went into commercial service, the Hiller 12 E had a head start. It had an Army-proved H-23D airframe and an Army-proved H-23D drive system that hadn't begun to exploit its full strength.

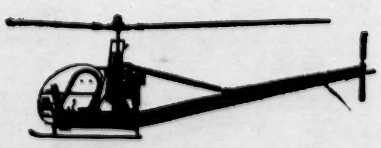
The next step rewrote the specs on what light utility helicopters can do. Capitalizing on the H-23D Raven's dynamic components with a 305 hp Lycoming engine's power, light helicopter "firsts" of the kind above were bound to happen. Similar profitable operations are flown every day, wherever there's an E.

That's why the 12 E has become first choice—it's the most economical helicopter purchase today.

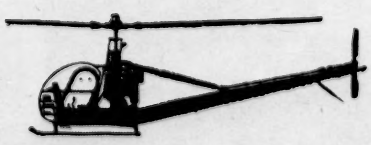
Designs are one thing. Deliveries another. Both come from

HILLER AIRCRAFT CORPORATION

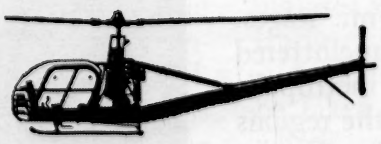
PALO ALTO, CALIFORNIA · WASHINGTON, D.C.
Adhesive Engineering Division · San Carlos, Calif.



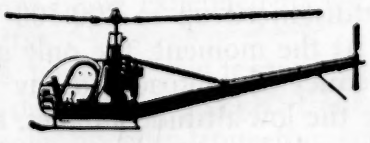
H-23D 250 hp



12 E 305 hp



E4 320 hp



Super E 340 hp

curiosities, strange-looking test aircraft with stranger flying characteristics. Today, while they are still far from the perfected form of the helicopter, these vertical risers have progressed to the point where new military specifications for fighters as well as transports are being written around the unique qualification of this type of airplane.

Fastest progress has been made in the field of GEMs. Not quite three years of development has taken these from laboratory toys to commercially sold vehicles.

Reasons Why

Behind any explosive growth rate there are solid technical reasons that explain the exponential curve of progress, and this is particularly true with the spectrum of vertical lift.

Biggest single factor in the development of all three types of these aircraft has been the second-generation gas turbine. The promise this type of engine showed in the 1950s is coming to fulfillment in the earliest years of the 1960s.

Lightweight, high-power units with extreme dependability and long life have made for a major discontinuity in development of the lifting vehicles. Formerly a large percentage of the total weight went into the powerplant necessary to lift that weight off the ground.

The cycle was almost self-destructive in some instances. The gas turbine changed that picture. It gave the designer a tiny package of hundreds of shaft horsepower in a minimum metal volume that two healthy men could lift. It has taken 10-15 years of aircraft gas turbine development to get these engines to their current state, where they can easily replace the highly developed piston engines that have traditionally powered the helicopter. Now they are on the scene as production engines, and they have made a difference in every approach to the design of the helicopter.

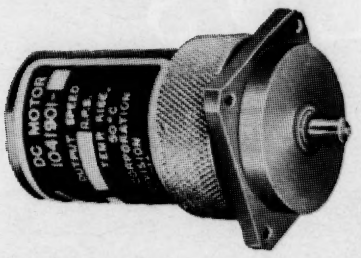
Evolutionary Changes

If the application of the gas turbine has been a revolutionary change, most of the other factors that have helped to perfect these aircraft have been evolutionary. There have been no major advances in aerodynamics or structural design in any of the three categories of vertical flight. There has rather been the application of well-known principles of flight or lift, finally made possible by a number of factors coming together at once.

There is still much potential in the helicopter. One authority estimates that current programs of rotor and fuselage drag clean-up, plus some advanced design techniques, could give

Bendix
MONTROSE DIVISION

D.C. MOTORS



OPTIONAL FEATURES

- MOTOR SPEEDS—7500 rpm, 9000 rpm, 12000 rpm. Other speeds available on request.
- GEAR RATIOS—5:1, 8.33:1, 20:1, 25:1, 80:1, 500:1, 1600:1.
- INPUT VOLTAGE—6 to 50 volts d.c. Standard models 12 and 26.5 volts d.c.
- GOVERNOR CONTROL RANGE—7500-14000 rpm.
- DUTY—3 watt continuous.
- BRUSH LIFE—to 450 hrs.

ENVIRONMENTAL CHARACTERISTICS

- TEMPERATURE— −65° F. to 200° F., standard models. −65° C. to 200° C., special models.
- VIBRATION—20 to 2000 cps at 16 g's.
- SHOCK AND ACCELERATION—30 g's.
- RADIO NOISE—Standard models available shielded to meet MIL-I-6181 radiated noise. Conducted noise met with external filtering. Also available unshielded.
- QUALITY—Parts manufactured to close tolerances and are 100 percent inspected. Motors pre-run to insure consistent performance. Type tests are performed on sample quantities of production units within our plant.

OTHER MONTROSE DIVISION PRODUCTS—

Synchros	Autosyn® Indicators
Dynamotors	Autosyn Pressure Transmitters
Pressure Switches	Autosyn Position Indicators
Ordnance Switches	D. C. Synchro Indicators

West Coast Sales and Service Office—117 East Providencia Avenue, Burbank, California
Canadian Sales Office—Aviation Electric Limited, 200 Laurentien Blvd., Montreal, Quebec, Canada
Export Sales and Service—Bendix International, 205 East 42nd St., New York 17, New York

For further information, write . . .
Montrose Division
SOUTH MONTROSE, PA.

THE Bendix CORPORATION

CIRCLE 253 ON READER SERVICE CARD

BOEING-VERTOL 107...

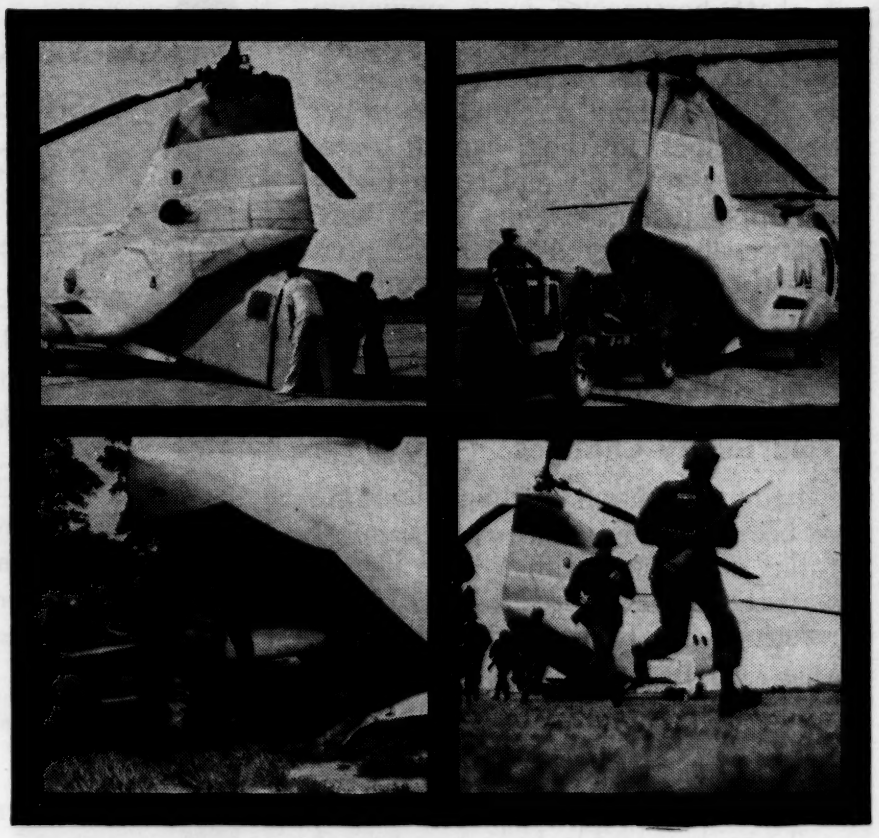
THE WORLD'S ONLY "MISSION MODULE" HELICOPTER

CONVERTS FROM MINESWEEPING TO ASW IN ONE HOUR

The new twin turbine-powered Boeing-Vertol 107 is the only helicopter flying today that can perform so many military missions – without costly conversion of the basic aircraft. The rear loading ramp and unobstructed cargo area permit a variety of modules or equipment to be quickly and easily installed on the 107, thereby enabling it to perform specialized missions for any and all military services. The Navy, for example, can use the Boeing-Vertol 107 for minesweeping and fleet utility duties and then, less than sixty minutes after mission completion, convert to anti-submarine warfare – simply by installing Vertol's ASW module.

Whatever the mission, the performance-proved Boeing-Vertol 107 offers features unmatched by any other helicopter – 150 mile-an-hour cruise speed . . . neutral directional stability at zero airspeed for any-wind hovering . . . a Vertol-developed stability augmentation system (SAS) provides fixed-wing aircraft stability which can be augmented with a trim system for automatic flight . . . tandem-rotor design that minimizes down-wash velocities . . . ability to land and take-off from water without special flotation gear.

These are just a few of the capabilities that make the Boeing-Vertol 107 the *first* all-mission, all-service helicopter.



VERTOL DIVISION
BOEING
MORTON PENNSYLVANIA

50% range increase, 20% maintenance decrease per ton-mile, and 30% increase in speed.

The next step is to compound the helicopter by unloading the rotor with small stub wings. Weight and performance increases follow, with reduced direct operating costs a dividend.

Payload Growth

Parallel to these improvements in detail design and concept will run growth increases, so that greater and greater payloads will be handled. The flying crane with 8- to 12-ton payloads will be operational with military units during this decade, one engineering expert says, and by the mid-1960s, use of the passenger pod should be developed to the point where the crane can be used to transport people during peak hours. During the latter years of the decade, the 20- to 40-ton cranes should appear.

The lines of V/STOL progress are not so clearly drawn. There is still much difference of opinion on optimum design for these aircraft, and there is just a beginning of common approaches to the problem in the discussion of desirable flying and handling characteristics.

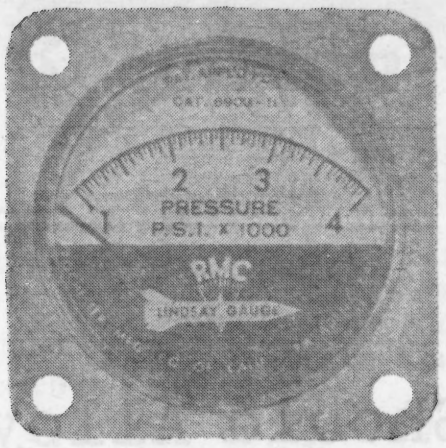
A dozen or more inventive approaches to the design of these vehicles have not yet produced a single "best" solution except in the views of each proponent. While there is complete agreement among designers of VTOL aircraft that they can do a unique job and do it well, there is complete disagreement on the best way to do the job.

GEM Limitation

In GEMs the picture is somewhat altered by the fact that there is a very limited number of approaches to the design. Perhaps the best aim of designers now is in determining roles and missions for the vehicles and in improving control systems and reaction times to control motion. The upper size limits of thousands of tons that used to be quoted as most efficient for the type have been revised downward so that optimum vehicles of 100 tons appear to be completely possible by careful design.

Although some of the backers of GEMs feel they work best in an environment where they have no competition, others see them as directly competitive with older, long-established forms of transportation.

Any general conclusion for the future of these vertical-lifting vehicles is impossible. Yesterday's visionary predictions of things to come have often been left behind in the turbulent wake of the fast-moving stream of aeronautical progress.



American-Standard PRODUCTS

What the affiliation of Rochester Manufacturing Co. with American-Standard® means to you

ROCHESTER INSTRUMENTS

Perhaps you read the story in the WALL STREET JOURNAL. "American Radiator and Standard Sanitary Corp. . . . has acquired Rochester Manufacturing Co., maker of gauges and instruments. Rochester Manufacturing, and Rochester Mfg. Co. of California, will operate as a part of American-Standard Controls Division."

There was more. But what is of immediate concern to you is: what does this consolidation of two great names in the field of gauges and controls mean to manufacturers of jet aircraft, missiles, and ground support equipment?

It means expansion of Rochester Instruments' basic engineering and research program and stepped-up new products development . . . reflecting broader product lines.

It means that the scope of the Rochester Instruments operation will be increased to serve industry more effectively.

It means that the complete facilities and capabilities of the American-Standard Controls Division are at the disposal of our engineers assisting you in subcontract projects.

In short, it means *growth* . . . greater resources, and development of important new products to take their place beside Rochester Pressure Gauges—and Detroit Electrosyn systems and Norwood Strain Gauge Pressure Pickup.

We look forward to the opportunity, as we always have, to help you keep pace with America's growth and development, but now we meet the challenge with a greater abundance of resources.

NORWOOD STRAIN GAUGE PRESSURE PICKUP (to 100,000 psi.)

RMC *The familiar RMC trademark,* symbol of quality instrumentation, has undergone a design change as a result of the affiliation of Rochester Manufacturing Co. with American-Standard. Here *(right)* is the new trademark for Rochester Instruments . . . and this is our new name: American-Standard Controls Division, ROCHESTER INSTRUMENTS, 1401-A South Shamrock Avenue, Monrovia, California.

ROCHESTER INSTRUMENTS

American-Standard PRODUCTS

AMERICAN-Standard

CONTROLS DIVISION

CIRCLE 255 ON READER SERVICE CARD 255

KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many who may find it useful to review fundamentals from time to time.

Steel *for Strength . . . Economy . . . Versatility*

When Should Alloy Steels Be Ordered to Hardenability?

What is hardenability and how does it differ in carbon and alloy steels?

Hardenability can be defined as the capacity of steel to develop a desired degree of hardness, usually measured in depth. It is produced by special heating and cooling. Carbon steel, except in small sections, will normally harden to a depth slightly below its surface, while alloy steel can, under certain conditions, harden uniformly through its entire cross-section.

Surface hardness obtainable after quenching is largely a function of the carbon content of the steel. Depth hardness, on the other hand, is the result of alloying elements and grain size, in addition to the carbon present in the steel.

In general, where hardenability is the prime consideration, it is not too important which alloy steel is used, just so long as there is sufficient carbon present to give the prescribed hardness, and there are enough alloying elements to quench out the section. It is not considered good practice to alloy a small section excessively, since excessive use of alloying elements adds little to the properties and can, in some instances, induce susceptibility to quenching cracks.

There are, of course, numerous cases where factors other than hardenability must be considered; such factors as low-temperature impact, heavy shock, creep-resistance, and the ability to resist temper brittleness. Through-hardening, therefore, is not always desirable. For example, shallow hardening is often necessary in shock applications, because a moderately soft core is essential.

This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts about Alloy Steels." If you would like a free copy, please address your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Circle Number 256 on Reader-Service Card

Business Flying Feels Recession Pinch

By Erwin J. Bulban

Business flying's effort to get off to a fast-moving start to fulfill expectations that 1961 would be its biggest year yet ran into trouble early this year overcoming the inertia of the recession in general business.

With the national outlook over the next few months uncertain, it becomes equally difficult to estimate what the business flying sales scoreboard will look like at year's end.

Best available opinion in the industry is that business flying probably will not set any new unit sales or dollar volume records this year. Rather, business probably will be close to 1960's record-breaking level of more than $200 million in retail sales of aircraft and parts.

Industry spokesmen say that if this does happen, then business flying will have proved its stability, just as it did in the 1958 recession when it actually showed a gain over 1957 in both dollar volume and units delivered.

Lower Profits

Profits will probably be down some, not merely on the basis of fewer sales, but because business flying is not retrenching in the sense that it plans to run with the business tide. Its strategy is to achieve the highest possible sales under the circumstances, which means that sales costs probably will go up. The factories, realizing that distributors' problems are closely akin to their own, will spend money to ease the burden on the field outlets. There will also be money spent on developing new models and new facilities that may not show a return for another year or so.

The recession is not all darkness. Domestic sales of new units may slide some, but it appears that export volume will show a continued healthy uptrend. It probably can not take up a major part of the slack that may develop in the U.S. market, however.

There are also indications that in a period of business difficulty company airplanes get high utilization so that industry executives can personally attempt to stay on top of operations at dispersed plants. Service operators are reporting increased fuel sales and maintenance business, alleviating to some extent the drop in their plane sales activities.

Key Factors

Key factors which intermeshed to increase the burden upon the industry and influenced the reactionary business turn included:

• **Abnormally high field inventories** of new 1960 airplanes at the close of last season's model year. Indications are that Beech and Piper were particularly affected by this problem, but Cessna less severely. Customers reacting to the recession became harder to sell and began delaying purchases several months, creating a somewhat similar situation to that faced by the automobile industry, except that the business airplane field is far more sensitive because of proportionately fewer outlets involved.

Dealers invested more heavily in inventory last year than usual to stock additional models that were introduced and they had more capital tied up in higher-cost used airplanes taken in trade. These trends added to the surplus of 1960 models especially aggravated distributor and dealer financial problems, since most dealers are accustomed to rapid turnover of a relatively small capital to maintain business.

This situation encouraged price cutting and taking of a smaller profit on sales of new and used airplanes. The result: slower airplane sales as the customer became aware of the situation and delayed to shop around.

Recession worries were one thing that slowed airplane sales soon after mid-1960. Resulting over-inventories were aggravated by still another situation. Influx of new dealers into the industry's sales organizations also resulted in build-up of surplus airplanes since some of these relatively new outlets took longer to get started and develop sales than had initially been expected.

• **Recession uncertainties** were increased with the advent of a new ad-

MOONEY MK. 21

CESSNA SKYWAGON

PIPER COLT

AERO COMMANDER 500A

ministration. Customers are saying they would prefer to wait a little longer, two or three months, before closing a deal to see what the new Administration will do, to see what it plans to spend on recovery programs and how in turn this will affect taxes.

• **Unusually bad weather**, particularly in the midwest and northeast, which was sustained over a longer than normal period this winter, tended to discourage prospects from taking a look at airplanes and cut into demonstration periods.

Manufacturers, aware that their fortunes are closely allied with those of their distributors and dealers, have been working with the field organizations to alleviate the roughest spots and indications are that the worst initial problems are out of the way. Distributors, aware that shortage of capital could put them out of business, have established longer lines of credit. One distributor obtained $450,000 in long-term credit to prevent being squeezed. In some cases distributors have called meetings of their dealers and their bankers to point out to the latter that this was the time for the banks to stand behind their customers with whom they had been enjoying good business.

Production Adjusted

Factories have reduced some original production schedules to keep their airplane inventory in line with demand. Beech Aircraft Corp., in its first quarter, ended Dec. 31, 1960, reported an 11% increase in commercial sales over the same period the previous year, but then January showed business down to about the same level as January, 1960, and February a slight decrease. In response Beech cut its production and delivery schedules by 20%, putting the plant on roughly the same schedule as this period the previous year. Beech had planned a 20% increase in production to meet earlier optimistic business estimates for 1961. Employment has dropped "several hundred" since December, though less than 40% is in commercial production.

Cessna, too, reduced its out-the-door rate. Because of its more favorable field inventory situation, it reported the best 1961 first quarter in the company's history. Now Cessna is maintaining a tight level of inventories since reports indicate that orders for February through April are down over the same period last year. In line with the production slow-down, it has laid off approximately 400 workers.

Spare parts business out of the factory has risen in line with reports that the current operating business airplane fleet is being used more because of industry's greater needs. Cessna

U.S. Business & Utility Aircraft Shipments—1960

(Number of Units, Builders' Net Billings—thousands of dollars)

Make and Model	January	February	March	April	May	June	July	August	September	October	November	December	Totals
Beech Model 18	8	11	9	10	6	6	5	6	6	5	4	5	81
Model 33 Debonair	20	23	28	44	34	17	3	9	7	4	23	26	238
Model 35 Bonanza	31	38	41	27	20	26	18	23	24	18	40	39	345
Model 50 Twin-Bonanza	11	9	11	8	12	8	5	7	3	0	5	8	87
Model 55 Baron	0	0	0	0	0	0	0	0	0	0	11	12	23
Model 65 Queen Air	1	0	2	6	6	7	6	9	9	4	9	7	66
Model 95 Travel Air	11	13	17	13	15	13	10	7	6	9	5	3	122
	$3,394	$3,943	$4,404	$4,447	$4,222	$3,666	$2,569	$3,285	$2,888	$1,988	$4,037	$4,218	$43,061
Callair A-5	0	0	3	1	1	0	2	1	0	0	0	1	9
A-6	0	1	1	0	0	0	1	0	1	0	0	0	4
	$0	$7	$28	$4	$6	$0	$20	$7	$7	$0	$0	$9	$88
Cessna Model 150	27	30	23	24	40	52	30	17	3	57	24	27	354
Model 172, Skylark	51	74	89	77	84	78	79	17	14	279	91	82	1,019
Model 175, Skyhawk	57	56	50	33	34	29	32	12	24	9	97	68	501
Model 180	27	33	25	27	26	28	21	8	21	13	23	31	283
Model 182, Skylane	59	82	80	59	61	51	46	28	43	18	17	123	667
Model 210	55	99	80	87	86	32	28	18	14	10	12	89	610
Model 310	29	26	35	26	30	26	25	11	22	18	21	21	290
	$5,008	$6,300	$6,203	$5,375	$5,719	$4,263	$3,966	$1,796	$2,796	$4,622	$4,060	$6,556	$56,664
Champion 7EC Traveler	3	4	2	5	1	1	2	1	4	1	4	5	33
7FC Tri-Traveler	12	7	5	6	3	1	2	3	5	13	10	5	72
7GC Sky Trac	0	7	2	4	0	1	0	0	0	0	0	0	14
7GCA, B Challenger	0	0	0	0	15	18	14	16	3	5	3	9	83
7HC DX'er	6	2	4	2	2	1	0	1	0	0	0	1	19
7JC Tri-Con	0	0	10	5	3	0	2	0	6	1	0	0	27
	$112	$112	$137	$137	$153	$143	$121	$137	$110	$117	$95	$118	$1,492
Commander 500 A, B	5	1	1	2	3	11	10	11	4	5	9	7	69
560 E	4	2	1	2	1	2	1	0	0	0	0	0	13
680 E, F	8	5	11	5	3	2	0	0	12	6	9	9	70
720	0	0	0	0	0	0	1	0	0	0	1	1	3
	$1,271	$630	$1,026	$722	$507	$1,011	$878	$688	$1,439	$866	$1,522	$1,357	$11,917
Lake LA-4	0	0	0	0	0	0	0	0	3	2	N.R.	N.R.	5
	$0	$0	$0	$0	$0	$0	$0	$0	$70	$45	N.R.	N.R.	$115
Mooney Mark 20	30	9	11	12	14	12	12	14	15	17	12	14	172
	$357	$104	$211	$231	$263	$233	$188	$215	$230	$262	$234	$253	$2,781
Piper PA-18 Super Cub	44	27	32	29	24	21	22	37	30	27	20	16	329
Colt	0	0	0	0	0	0	0	0	0	0	11	16	27
PA-22 Tri-Pacer	72	58	62	39	31	32	23	37	29	11	10	15	419
PA-23 Apache	8	8	2	0	2	12	6	8	11	3	20	22	102
PA-23 Aztec	4	43	44	48	46	40	19	25	26	12	13	9	329
PA-24 Comanche 180	59	34	42	23	22	24	15	14	13	7	10	12	275
PA-24 Comanche 250	43	68	56	29	56	32	28	30	20	17	48	42	469
PA-25 Pawnee	19	38	42	58	50	54	29	11	8	5	33	16	363
	$2,837	$4,368	$4,181	$3,538	$3,842	$3,483	$2,093	$2,433	$2,249	$1,196	$2,613	$2,269	$35,102
Totals (Aircraft)	704	808	821	711	731	637	497	381	386	576	595	741	7,588
Totals (Net Billings)	$12,979	$15,464	$16,190	$14,454	$14,712	$12,799	$9,835	$8,561	$9,789	$9,096	$12,561	$14,780	$151,220

N.R.— Not Reported.

factory parts business in the last fiscal year approximated $3 million, and was projected for $3.2 million this year. At the end of the company's first quarter, Cessna was reporting spares business $200,000 over projections for the period. Approximately one-third of field service parts requirements is supplied by the factory.

Favorable Projection

Commander, Inc., reports that it believes that 1961 will be a better year than 1960 and is aiming for a 20% increase in business. It has experienced a production cutback, but says this was primarily due to a step-up last year to get its new airplanes out the door and that its production now is within three or four airplanes of what it was at the same time a year ago. Expectations are that it will show a production average of 15 airplanes monthly for the first two months of 1961. Output currently is based on a 16-hr. production line.

It set a price reduction in the Model 500-A, from $75,000 to $67,500. This was done because the original price increase, from $72,000 to $75,000, made after adding some equipment to the basic airplane and increasing the gross weight 250 lb., brought the 500-A too close to the 500-B Commander and therefore made the airplanes competitive between themselves.

Mooney Aircraft, builder of the Mark 21 four-placer, also looks optimistically at business in 1961. It still is aiming to double production over 1960 with the new model, which has been revised to all-metal construction, and produce 300.

Mooney's expansion program requires additional financing to build inventories of materials. Retooling to the all-metal configuration was costly and President Hal Rachal has been raising additional funds by sale of treasury shares with which he hopes to obtain approximately $400,000 needed to supply the production lines.

Companies report that in line with an aggressive approach towards the recession, their dealers and distributors are putting on more salesmen and plan to improve sales capabilities by taking advantage of company training schools.

Manufacturers are going ahead with their programs to continue increasing the number of dealers.

Biggest thing in their favor, they report, is that theirs is nowhere near a saturated market. A period of business recession is the time company-owned airplanes can really pay off for management in enabling executives to cover more territory faster.

Plans Move Ahead

Plans are going ahead for production of 1962 lines, which will be out this fall. Prototype designs are frozen, materials inventories are being stocked, and, in many cases, some parts are already in production. Materials orders actually are placed in stages so the danger of being caught with overages is not particularly acute since these can be paced to some extent by current business conditions.

Picture on new models in the line varies. Indications are that Beech has

Not necessarily in words and syllables
but in electronic impulses, relayed by orbital, lunar and
interplanetary communications systems.

Scientific advancement depends upon the ability of man to overcome the limitations of current knowledge. These limitations are being pushed aside at the Amherst Laboratories by new concepts for aerospace communication and instrumentation systems.

The role that microwave and millimeter wave technology will assume in future aerospace systems is being shaped through state-of-art advances achieved by our technical staff.

PROFESSIONAL STAFF APPOINTMENTS *in Microwave Communication Systems are available for Electronic Engineers, Physicists and Mathematicians with advanced degrees and creative desire.*

You are invited to direct inquiries in confidence to Mr. E. Schlichter, Manager, Microwave and Aerospace Systems Department, Amherst Laboratories . . . or call NF 3-8315 for information. All inquiries will be acknowledged promptly.

SYLVANIA ELECTRONIC SYSTEMS
A Division of SYLVANIA
Subsidiary of GENERAL TELEPHONE & ELECTRONICS
1180 Wehrle Drive, Williamsville, New York

AMHERST LABORATORIES

Shrinking the Universe . . . through Communications

ordered a slowdown in the development schedule on its four-place fixed tricycle landing gear $10,000-class lightplane and chances are that this will not be out this year. The 1961 light-twin Travel Air—which will feature fuel-injection engines as the big improvement over previous models—is still scheduled for debut this month. Cessna is going ahead on the four-place pusher-tractor twin-boom light-light twin and the Model 320 five-place 260-hp. supercharged Continental-powered higher-performance version of the 310F light twin, both of which will be in the 1962 line. There reportedly has been some reduction in effort on development on the heavy-light twin 6-10 placer, but this was not scheduled for delivery until late 1963 or early 1964. Both the light-light twin and Model 320 have been scheduled to begin flight tests before April.

Export Sales

The export situation continues to be bullish. Business flying will show marked improvement in sales abroad this year over last, which was an exceptionally good year. Beech Aircraft echoes industry sentiments that the export outlook for 1961 is very good, with no signs of a recession in any major deliveries and backlog for its four months ending in January were 100% over the same period a year ago. The company expects that its final year-end tally will show export sales increased 50% over 1960. Last year showed a gain of 100% over 1959 in foreign sales.

Europe has become a prime export market, having overtaken the Canadian market in the past four or five years. Continued economic and political instability in South America has held down this area's potential. European countries have made vigorous economic comebacks and now are more independent financially of the United States than at any time since the war. As prosperity increases in this area, the public's demand for a higher living standard increases and the result is good for business.

Increasing Interest

Another favorable factor has been increasing interest by the Export-Import Bank in aiding financing of airplanes abroad. Recent shipment of 37 single-engine aircraft to Australia by Cessna, with a value of more than $500,000, is evidence of the importance of such support.

This is believed to have been the largest single shipment of business aircraft to that country.

Increased distributor and dealer sales and service facilities abroad and the fact that U. S. business aircraft manufacturers have been providing their ex-

port departments with heavier support in the way of demonstrator aircraft all have been paying off, laying a foundation for future substantial increases in sales growth abroad.

1960's High Mark

Although U. S. business plane manufacturers on the average appear to believe that they will not achieve a substantial sales and unit delivery gain in 1961 over the past record breaking year, 1960's mark was favorable enough so that if they come close to it they will still be in a strong sales position.

Retail sales of $200 million-plus last year exceeded the previous year by better than $30 million and provided the industry with total factory net billings of better than $151 million compared with 1960's billings of nearly $130 million.

Not included in these figures is the additional millions of dollars spent by owners on their aircraft on additional navigation and communications equipment installed after the aircraft left the factory.

Noteworthy was the steady rise in sales of twin-engine airplanes. Last year 1,225 of this class were delivered compared with 996 in 1959. To point up the claim by manufacturers that they are only scratching at a nonsaturated market, it is interesting to note that in most cases, as competitive models are put out by each manufacturer, the end-of-year sales tallies usually show a marked rise in total sales in this class, supporting their point that harder selling resulted in increased sales not to the detriment of competing makes.

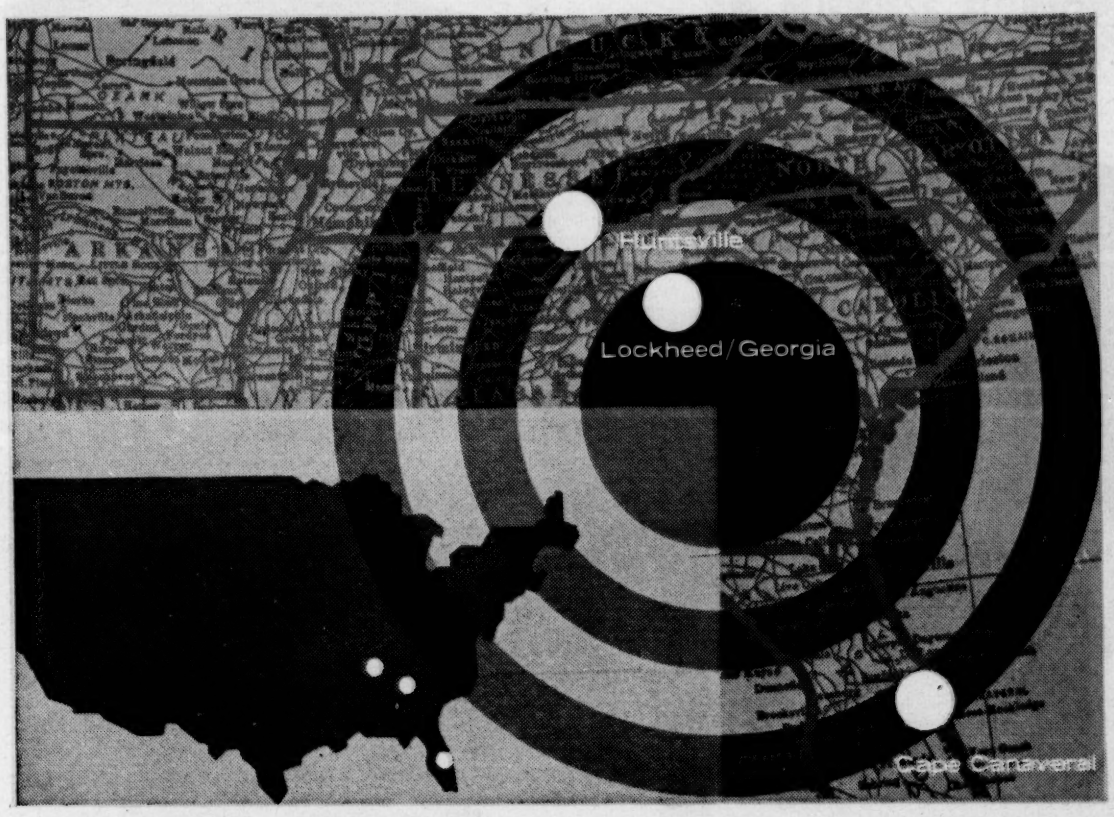
To back up their thesis that the industry needs more airplanes specifically tailored to the customer's wants, manufacturers continued to increase their model lines.

Beech Adds Baron

Beech last year added the Baron, which Beech says has been such a success that it has not been affected by the business slow-down. Cessna brought out the new Model 185 Skywagon utility airplane, which will probably compete with the Lockheed LASA-60 in foreign markets, and added the Skyhook helicopter to the line. Piper brought out the four-place fixed-gear Cherokee and two-place Colt in an effort designed to penetrate the low-price class.

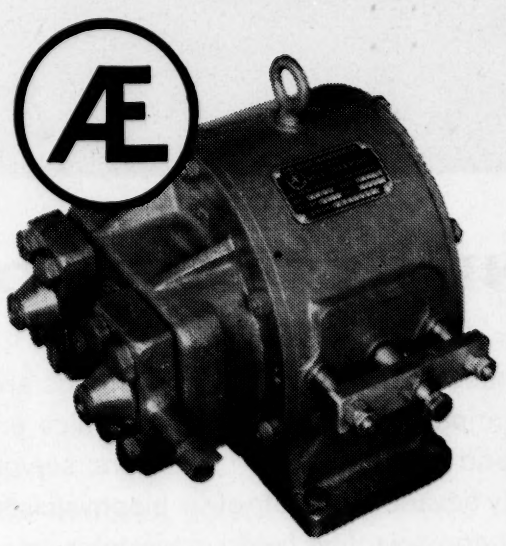
Business flying operations last year continued its rise.

Pilots logged approximately 6.1 million hours in 1960—more than twice those flown annually by the nation's scheduled domestic airlines, the Federal Aviation Agency estimates. Only a decade ago, business flying hours totaled 2,950,000 annually.



STRATEGIC AEROSPACE CENTER ▪ Lockheed/Georgia is next door to Huntsville and Cape Canaveral. This strategic geographic location eliminates excessive transportation costs, makes technical liaison more efficient, and reduces the overall time span of aerospace programs. And the Georgia Division is big enough physically to handle any program yet conceived—big enough in capability to take on the full gamut of advanced research and manufacturing jobs. **LOCKHEED/GEORGIA**
MARIETTA, GEORGIA

IMPORTANT NEWS
FOR HYDRAULIC PUMP USERS



AMERICAN ENGINEERING'S HELE-SHAW and **HYDRAMITE** pumps are now being precision engineered and fabricated at the Aircraft Armaments, Inc. plant at Cockeysville, Md.

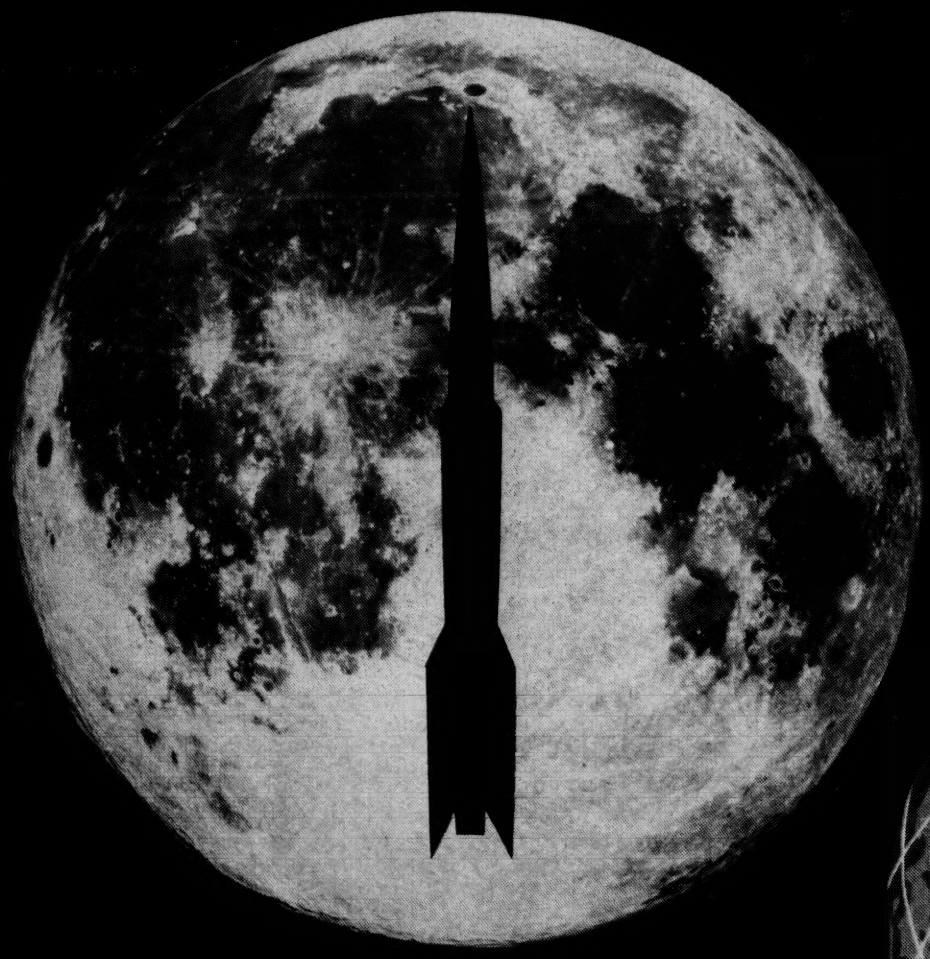
Be assured that the same craftsmanship and high standards of quality which make **HELE-SHAW** and **HYDRAMITE** pumps leaders in their field will be maintained in the **IMMEDIATE CONTINUED PRODUCTION** of these pumps by Aircraft Armaments, Inc.

Please address inquiries to:

AE INDUSTRIAL DIVISION
AIRCRAFT ARMAMENTS, INC.
Post Office Box 6853, Baltimore 4, Maryland

CLEVELAND DISTRICT: A. E. Company, 1157 Leader Bldg., Cleveland 14, Ohio
NEW YORK DISTRICT: AE Industrial Division, 1 Exchange Place, Jersey City 2, N. J.

Circle Number 263 on Reader-Service Card



SPACECRAFT

AIRCRAFT

NOW UNDER ONE ROOF AT LOCKHEED / BURBANK

Lockheed California Division has expanded its already great resources at Burbank. For it now encompasses, under one roof, the two vast worlds of Spacecraft and Aircraft.

This typifies Lockheed policy to steadily advance the state of the art through basic research in related and scientific fields.

Result? Now—more than ever—Lockheed offers Scientists and Engineers uncommon opportunities; equips them with every modern facility; gives them freedom to explore and express new ideas; makes possible greater individual recognition.

Now being designed and developed in Spacecraft and Aircraft are: Hypersonic interceptors; V/STOL; supersonic interceptors; limocopters; missiles; manned spacecraft; and satellites.

Scientists and Engineers of outstanding talent are now invited to participate in this new, dual enterprise. Immediate openings are available to: Aerodynamics engineers; thermodynamics engineers; dynamicists; electronic research engineers; servosystem engineers; electronic systems engineers; biophysicists; infrared physicists; hydrodynamicists; ocean systems scientists; physio-psychological research specialists; mammalian culture research specialists; and radiation hazards specialists.

Write today to Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1103, 2406 N. Hollywood Way, Burbank, California.

LOCKHEED

CALIFORNIA DIVISION

POTEZ 840 PROTOTYPE

Europe to Compete for Lightplane Sales

Geneva—European lightplane manufacturers are placing increasing emphasis upon the potential of export sales within the U. S. and other market areas that have been almost exclusively American over the past few decades.

Although relatively small and encumbered by the fact that business flying in Europe has been retarded by a number of obstacles, the industry is growing and broadening its scope of activities. Companies in France, Great Britain, West Germany, Israel, Italy and Switzerland are making—or will soon make—determined bids to capture their share of the export market with models ranging up to and including multi-passenger jet executive transport designs.

From the east, Czechoslovakia is seeking its share of the Western export market with a number of lightplane designs.

Growth Barriers

For the moment, European buyers are still giving preference to American designs, and the barriers to business flying within Europe itself are still great. They include:

- **Comparatively few** landing strips for small aircraft.
- **Lack of navigational aids.**
- **High landing fees.** For aircraft in the 8,800-lb. category, for example, the charge is around $8, with lights $12.
- **Expensive aviation fuels**—primarily because of high taxes. A typical example is in France, where total cost per gallon is about 70 cents more than in the U. S.
- **Import duty** on foreign aircraft that increases the initial cost considerably —17½% in the United Kingdom, for example. It is one of the major reasons a growing number of European manufacturers are moving to produce some of the popular foreign types under license in their respective countries.
- **Shorter distances** in Europe than in the U. S., making surface transportation highly competitive.

Britain appears to offer particularly good prospects of expansion in the business flying field in Europe during the next decade, particularly if projects such as the European Common Market demand closer contact with various branches of industry located on the Continent.

At the moment, 90-100 British companies operate their own craft from just about as many airfields available for private flying. Latest British Air Registration Board figures show that, compared with 360 small aircraft flying in the U. K. in 1959, there were 512 in 1960. Of these, 343 were registered as belonging to flying clubs and private owners. Many of the latter group use them for business purposes as well as for week-end flying. The remaining 169 were in use for training.

A relaxation of aircraft import restrictions 18 months ago resulted in boosting the sale of American light aircraft in the United Kingdom. During that period, 150—chiefly Cessna and Piper airplanes—were imported, representing a value of approximately $2.8 million.

As in the U. S., there is a decided shift in preference in Europe to higher powered, twin-engine business aircraft with longer range and higher ceiling.

Jet Trend

Another marked trend in European light aircraft design is the development of jet-powered executive types. Recent developments aimed specifically at the U. S. market include:

- **Twin-engine**, eight-seat executive jet, the SAAC 23, to be produced jointly by Swiss Aviation Corp., Delaware, and a subsidiary, Flugzeugentwicklung A. G. of St. Gallen, Switzerland. Both of these newly formed firms are headed by the American industrialist, William P. Lear, Sr. Engineering work on this design is to be carried out by the Swiss company. Swiss American Aviation Corp. is to be responsible for installation of the powerplant, probably two General Electric CJ610 jet engines, and for final assembly. Production is scheduled to begin early in 1963 at a predicted rate of about 100 units yearly. The standard model SAAC 23 is expected to cost $250,000.
- **B101C**, a twin-engine, seven-place

Money

alone is not a true measure of an engineer's satisfaction

But you can't eat satisfaction! That's why our pay scale matches anyone's and, in many instances, is better.

However, an engineer's *inward* fulfillment comes from a difficult job well done, not just from counting the digits on his check. Satisfaction from whipping a problem, finding the answer, making the answer work. Call it what you will, pride, ego, or what have you, it remains *the* most necessary ingredient a good engineer must possess. Our engineers have it and their fine creative performances show it.

Because RCA West Coast continues its rapid expansion movement, we're looking for this kind of satisfied engineer right now. Are you one of these:

Advanced Systems Engineers, Development and Design Engineers, and Project Engineers with experience in these areas: Electronic Countermeasures, Data Processing and Computer Systems, and Missile Ground Support Systems.

For more about us and your profitable future, follow the advice in the box at right.

RCA
WEST COAST

Call collect or write:
Mr. T. M. Ripley
EMpire 4-6485
8500 Balboa Blvd.
Dept. 561-C
Van Nuys, California

RADIO CORPORATION OF AMERICA
WEST COAST MISSILE AND SURFACE RADAR DIVISION

The name you know is the place to grow!

EQUAL JOB OPPORTUNITY For All Qualified Applicants

SPECIFIC OPENINGS AT RCA WEST COAST ARE:

SENIOR COMPUTER SYSTEMS ENGINEERS
To lead studies in new organizational concepts, pattern recognition and machine learning. Will be a member of high level Research and Development team working on RCA Sponsored Programs.

SENIOR COMPUTER ENGINEERS
To lead applied research studies on kilomegacycle computer circuits. Will work with advanced R & D team.

DIGITAL SYSTEMS ENGINEERS
For design and application of digital data processing equipment to military systems. Also for conceptual design, synthesis, and analysis of military systems utilizing digital techniques.

ECM ENGINEERS
For project equipment utilizing new and unique high frequency and video circuit techniques.

SYSTEMS OPTIMIZATION ENGINEERS
For application of operation analysis and other analytical techniques. Advanced degree.

OPERATIONS ANALYSTS
For development of large scale systems concepts. Familiarity with logical and/or mathematical models for data processing systems necessary. Advanced degree in Mathematics preferred.

DESIGN AND DEVELOPMENT ENGINEERS
For control equipment, display equipment, and design of analog and display circuits.

SENIOR LOGIC DESIGN ENGINEERS
To design entire computer systems. Advanced degree preferred.

SENIOR ENGINEERS
For relay logic and relay switching design and application to advanced digital techniques.

PROJECT ENGINEERS
For technical project management of development and design engineering and customer liaison and manufacturing. Responsibilities include project direction, control and proposals for improvement and extension of digital system capabilities.

PROJECT ENGINEERS
For visual data handling and analog data processing, employing direct view storage techniques, alphanumeric readout devices and projection systems.

For complete details on these positions contact Mr. O. S. Knox at RCA West Coast.

jet, is currently being built by Israel Aircraft Industries of Tel Aviv. Cost of the standard model is quoted as around $300,000, initial deliveries to begin in 1962. The B101C also probably will be powered by General Electric CJ610 engines.

• **Piaggio** design with Douglas Aircraft Co. technical support and 50% Italian government financing. The aircraft will reportedly be in the 12,000-lb. gross weight class, incorporate a gull wing and be powered by Canadian Pratt & Whitney PT6 engines. Piaggio also is considering a straight-wing, 3,000-lb.-thrust Pratt & Whitney JT12-powered version.

• **Ernst Heinkel Flugzeugbau** G.m.b.H., Speyer/Rhein, is developing with Potez Air Fouga of France a four-seat, twin-jet transport designated CM 191. First prototype is expected to fly in May.

British light aircraft designers are following the general trend in the twin-piston engine field. One example is the new light aircraft development company, BEAGLE, British Executive & General Aircraft, Ltd. This firm reportedly has several executive-type aircraft in various stages of construction. One of them, a twin-engine model, is expected to make its first public appearance at this year's Farnborough Air Show in September.

BEAGLE Projects

Another design is a much improved Auster, the Auster-Beagle. It is believed to seat four and to be powered by a single Continental engine which Rolls-Royce is producing under license. It is scheduled to be shown at Baginton Airport near Coventry, England, on April 28-30 this year.

Dornier-Werke G.m.b.H. of Munich, leading German light aircraft manufacturer in sales volume, was the first German producer to introduce commercially a twin-engine model, the six-seat Dornier Do.28 STOL aircraft. Based on its predecessor, the single-engine Dornier Do.27, the first Do.28 prototype was shown at the 1959 Hanover air show. Featuring increased power and wing area, the second prototype Do.28 made its first flight in March, 1960, and was demonstrated at Hanover in April.

Dornier also plans a sales drive for both types, particularly the Do.28, in the U. S. after certification by the Federal Aviation Agency.

Do.28's export price of approximately $47,000 is expected to be competitive with similar U. S. models (AW Nov. 14, p. 135).

Bolkow-Entwicklungen K. G. of Munich is next on the list of leading German light aircraft manufacturers. This company has grown from modest postwar beginnings to one of the most versatile in the German aviation industry.

Its products include powered sailplanes, helicopters, helicopter trainers, simulators, rocket motors, guided missiles and sport and touring aircraft. It is building the Klemm Kl-107C two-seat monoplane under license at its Nabern/Teck works and last year sold a total of 50 of this type on the home market, to Switzerland, Sweden, Pakistan and Iran.

Production rate is between five and eight units a month, according to demand.

German Lightplane

Based on the Klemm Kl-107C, Bolkow has developed its own four-seat, single-engine design. It is designated Bolkow F-207, but, apart from a scheduled first production series to start in May at a rate of about 10 a month and gradually to be stepped up to approximately 15 monthly, details of this new type are not yet available.

Another German lightplane is the Elster-B Magpie two-seat, single-engine sport plane built by Alfons Putzer K. G., Flugzeugbau at Bonn. A number of these are in service with sport groups of the German Luftwaffe.

Rhein-Flugzeugbau G.m.b.H., Krefeld-Uerdingen, are producing the RW.3a tandem, two-seat multoplane which, by fitting wing extensions to the standard RW.3a model approved for aerobatics, can be converted into a power-assisted glider with dual controls.

It is being used in Germany for training, sport flying and touring and, following its appearance at last year's Hanover air show, aroused interest among a number of prospective buyers in America.

Rhein-Flugzeugbau also is developing a six-seat, twin-engine push plane, the RF-1, which can be adapted for freight-carrying or ambulance duty by removing its two rear benches.

Flight trials of the first prototype are scheduled to begin shortly (AW Dec. 19, p. 111).

Austrian light aircraft production is represented by two firms: Simmering-Graz-Pauker A.G. of Vienna, who introduced their twin-engine, four- to five-seat M.222 Flamingo aircraft at the 1959 Paris air show, and Josef Oberlerchner – Holzindustrie, Spittal-Drau, whose first prototype Job 5 two- to three-seat single-engine monoplane began final type tests in January, 1960. Neither of these two aircraft has been sold in quantity thus far.

The same applies to Switzerland's latest lightplane, the six-seat, single-engine multi-purpose Pilatus Porter, built by Pilatus Flugzeugwerke A.G.

NEW

Outstanding space scientists assess the role of science in the space-age

Today's advances in space knowledge . . . and tomorrow's almost limitless opportunities for experiment and research in all areas of space science are described in this volume. Many of the world's leading scientists discuss spacecraft experiments —applications within reach in weather forecasting, communications, and geodesy — man's role in space — and other key areas of space science and technology.

Partial Contents

• Results of experiments in space • knowledge of the earth from space • rocket research and the upper atmosphere • satellites and the upper atmosphere • interplanetary gas and magnetic fields • galactic and extragalactic astronomy • the biological sciences and space research • exobiology: experimental approaches to life beyond earth

Soon to be Published

SCIENCE IN SPACE

Edited by LLOYD V. BERKNER, Chairman; and HUGH ODISHAW, Executive Director, both of Space Science Board, National Academy of Sciences

439 pages, 6 x 9, 106 illustrations and tables

Leading scientists actively engaged in various aspects of the space effort discuss the actual and potential role of science in space. In addition to reviewing current achievements and problems, the book considers the nature of gravity—space-vehicle experiments— fields and particles in space—and other timely and important topics.

Are you keeping your space-technology bookshelf timely with these guides?

SPACE FLIGHT

Discusses space-vehicle design and development, human factors in space flying, communications in space, etc. **By C. Adams. 364 pp., 50 illus., $7.00**

REALITIES OF SPACE FLIGHT

Experts write on interplanetary flight, physical and biological aspects, testing stations, and more. **Edited by L. Carter. 417 pp., illus., $8.00**

MISSILE CONFIGURATION DESIGN

In Press. Presents basic principles of configuration design of guided missiles, emphasizing aerodynamic considerations. **By S. Chin. 300 pp., 159 illus.**

GUIDED MISSILES

Covers operation, design, and theory of guided missiles . . . how they are tested and used. **Sponsored by Dept. of the Air Force. 546 pp., over 500 illus., $9.00**

MISSILE AERODYNAMICS

Explains principles of missile aerodynamics . . . treats bodies, wings, tails, and their various interactions. **By J. Nielsen. 431 pp., 213 illus., $12.50**

SOUNDING ROCKETS

Describes high-altitude research rockets —their uses, methods of application to research, problems encountered. **By H. Newell, Jr., 334 pp., illus., $12.50**

GUIDED MISSILE ENGINEERING

Principles and techniques of the various sciences that make up the missile engineering field. **By A. Puckett and S. Ramo, 512 pp., 213 illus., $10.00**

INTERNAL BALLISTICS OF SOLID-FUEL ROCKETS

A wealth of data on military rockets using dry-processed double-base propellants as fuels. **By R. Wimpress, 208 pp., 152 illus.,$7.50**

PROPULSION SYSTEMS FOR SPACE FLIGHT

Covers design and operation of engines for use in space—from turbojets to photon-propulsion. **By W. Corliss, 312 pp., 149 illus., $10.00**

INTERNATIONAL MISSILE AND SPACECRAFT GUIDE

Just Out. Authoritative facts, figures, and background on significant U. S. and foreign rockets, missiles and spacecraft are provided in this comprehensive guide. **By F. Ordway III, NASA; and R. Wakeford, Melpar, Inc. 411 pp., 861 illus., $25.00**

JANE'S ALL THE WORLD'S AIRCRAFT 1960-61

In Press. This latest edition contains a detailed account of all aircraft, engines, guided missiles and space vehicles currently in production or development. **Edited by John W. R. Taylor, 594 pp., over 1100 illus.**

FREE EXAMINATION COUPON

McGraw-Hill Book Co., Dept. AV-3-13, 327 W. 41st St., N.Y.C. 36

- ☐ Berkner & Odishaw—**Sci. in Space**—In Press
- ☐ Adams—**Space Flight**—$7.00
- ☐ Carter—**Real. of Space Travel**—$8.00
- ☐ Chin—**Guided Miss. Config. Design**—In Press
- ☐ Dept. of Air Force—**Guided Miss.**—$9.00
- ☐ Nielsen—**Missile Aerodyn.**—$12.50
- ☐ Newell—**Sounding Rockets**—$12.50
- ☐ Puckett & Ramo—**Guided Miss. Eng.**—$10.00
- ☐ Wimpress—**Inter. Ball. of Solid Fuel Rockets** $7.50
- ☐ Corliss—**Propul. Sys. for Space Flt.**—$10.00
- ☐ Ordway & Wakeford—**Intl. Miss. & Space. Guide**—$25.00
- ☐ Jane's—**All the World's Air. 1960-61**—In Press

Send me book(s) checked at left for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privilege.)

Name .....

Address .....

City ..... Zone.... State.....

Company .....

Position .....

For price and terms outside U. S. write McGraw-Hill Intl., N.Y.C. **AV-3-13**

● BUSINESS FLYING

Stans. First prototype was introduced at the 1959 Paris air show, and Swiss Alpine rescue pilot, Herman Geiger, recently took delivery of the second.

Prominent examples of the Italian lightplane industry include the Falco F.8 two-seat monoplane, the four-seat F.14 Nibbio and the P.19 Scricciolo two-seat trainer designed for flying clubs and private flying. All three types were built by Aviamilano of Milan. The Falco F.8, a modified version of which, the Falco F.8.L America, is being produced under license by Aeronere, Trento, made its first flight in April, 1956.

Production rate is one a month and thus far a total of 21 have been sold —primarily to Italian aero clubs.

Aviamilano is also producing one four-seat F.14 Nibbio a month and has now sold a total of 11.

The Scricciolo's production rate is four a month, and a total of 15 have been sold thus far. Originally, the firm planned to produce 50, but, based on the result of recent market investigations, chiefly in Italy, a total production run of about 200 units is now planned.

Macchi is building the Lockheed LASA 60 high-wing monoplane under license. Because of delays in delivery of components, the initial flight date has slipped slightly and is now scheduled for late March this year.

The company expects to produce 75 units in 1961 and 100-150 aircraft in succeeding years, according to demand. None have been sold so far because Macchi says it is adhering to its firm policy against signing agreements until the prototype has been thoroughly tested.

Piaggio Orders

Piaggio & C. of Genoa has produced a total of 30 Piaggio P.166 twin-engine, six-to-eight seat executive transports, the first three production models of which were completed around the middle of 1959. The aircraft is powered by two 340-hp. Lycoming GSO-480 engines and is presently coming off the production line at about four a month.

Thus far, it has been sold in Italy, England, West Germany, Sweden, Australia and Africa. Cost of the standard model is about $96,000.

Both P.166's predecessors—the P. 136-L-1 and -L-2 have been license-produced and marketed under the name of Trecker Gull by the Trecker Aircraft Corp. of Milwaukee, Wis. Trecker also marketed the Piaggio P.166 executive transport in the U.S. The company's five-year-old license agreement with Piaggio recently expired, however, and has not been renewed. Piaggio has halted production of the P.136 series.

The French aircraft industry is currently including lightplanes in its present drive to capture a bigger share of export markets for its products. So far, the home market has been the French small aircraft builders' main outlet. Now several companies are producing light aircraft designed to be sold and serviced in international markets, particularly other European countries and Africa. Such types include:

• **Morane-Saulnier's** all-metal, three-seat sports plane, the M.S.880 Rallye. At the end of January this year, the company said it had received 166 firm orders, 85 of which came from 17 foreign countries.

• **Wassmer W.A.40 Super IV** four-seat monoplane built by Soc. des Etab. Benjamin Wassmer, Paris. According to company officials, the Super IV was designed to meet a budding demand in Western Europe for a combined business-touring aircraft, which would be comfortable, reasonably fast—165 mph. cruise—and less expensive than comparable U.S. types with a $15,200 price tag. Production rate of the Super IV is currently two a month and to the end of the year 11 of this type had been sold.

• **G.Y.80** four-seat, all-metal aircraft, designed by Max Gardan and to be built by Hurel-Dubois, is slated to go into production this summer at a rate of five a month, priced around $13,000. The G.Y.80, similar in appearance to the Piper Comanche, has a 150-hp. Continental O-320 powerplant. The aircraft, which is expected to sell widely throughout Western Europe, is currently undergoing final flight tests prior to certification.

• **M.L.-145 Rubis** is expected to make its initial flight this summer. Built by Scintex S.A., Courbevoie, Seine, the low-wing Rubis monoplane has a 145-hp. Continental engine.

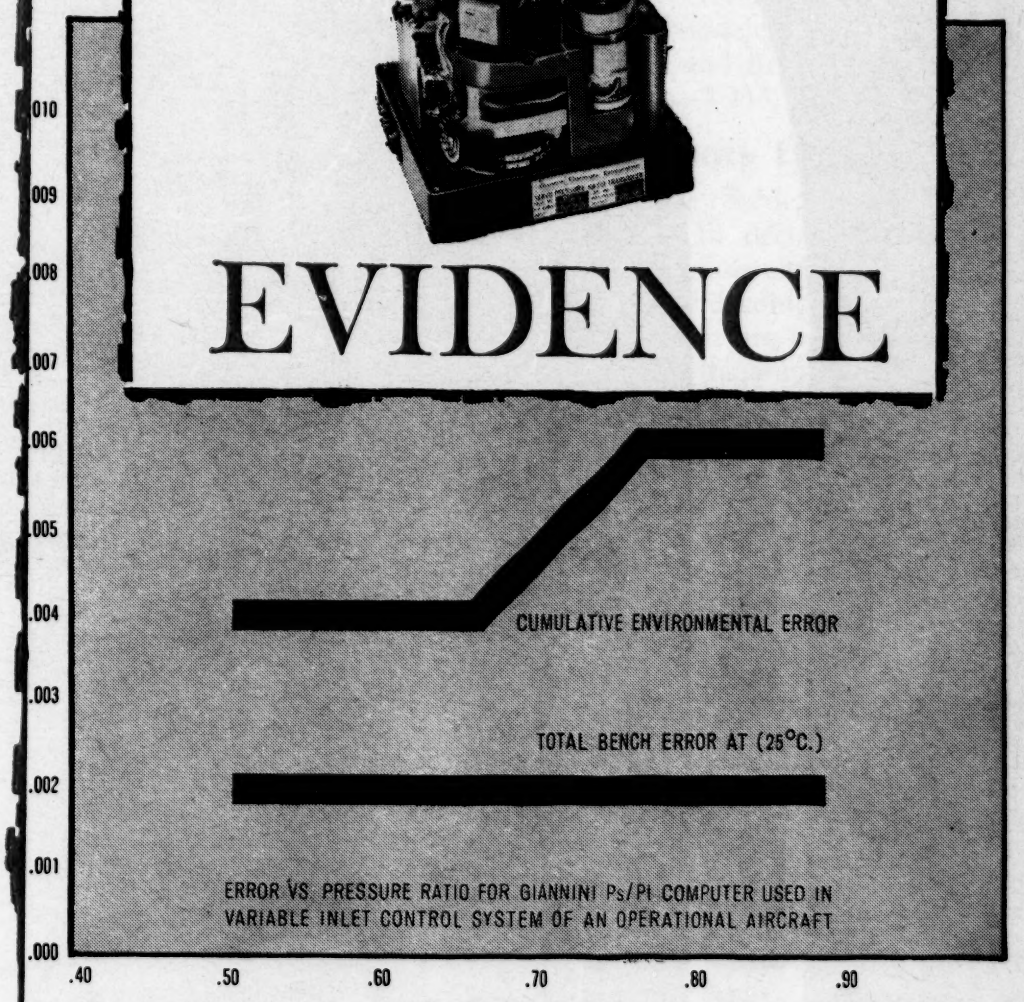
In the light twin-engine field, French efforts are centered on a Beech Travel Air, or Baron, retrofitted with two Turbomeca Astazou turboprop engines of 470 shp. Early this year, Beech Aircraft Corp. signed agreements with the French SFERMA company, a subsidiary of Sud Aviation, covering the commercial and technical exploitation of this retrofitting program. SFERMA already has logged considerable flying time on one Turbo-Travel Air and recently began flight testing a second.

The turbine version of Travel Air offers a maximum speed of 310 mph. compared with 209 mph. for the piston-engine version. The turbine Travel Air will climb out at 3,149 fpm. compared with 1,360 fpm. for the piston-engined model. Beech Aircraft Corp. and SFERMA hope to begin commercial exploitation of their agreement later this year.

HOW RUGGED, SENSITIVE,
AND RELIABLE
IS A GIANNINI FORCE BALANCE
PRESSURE TRANSDUCER?
HERE'S

GRAPHIC

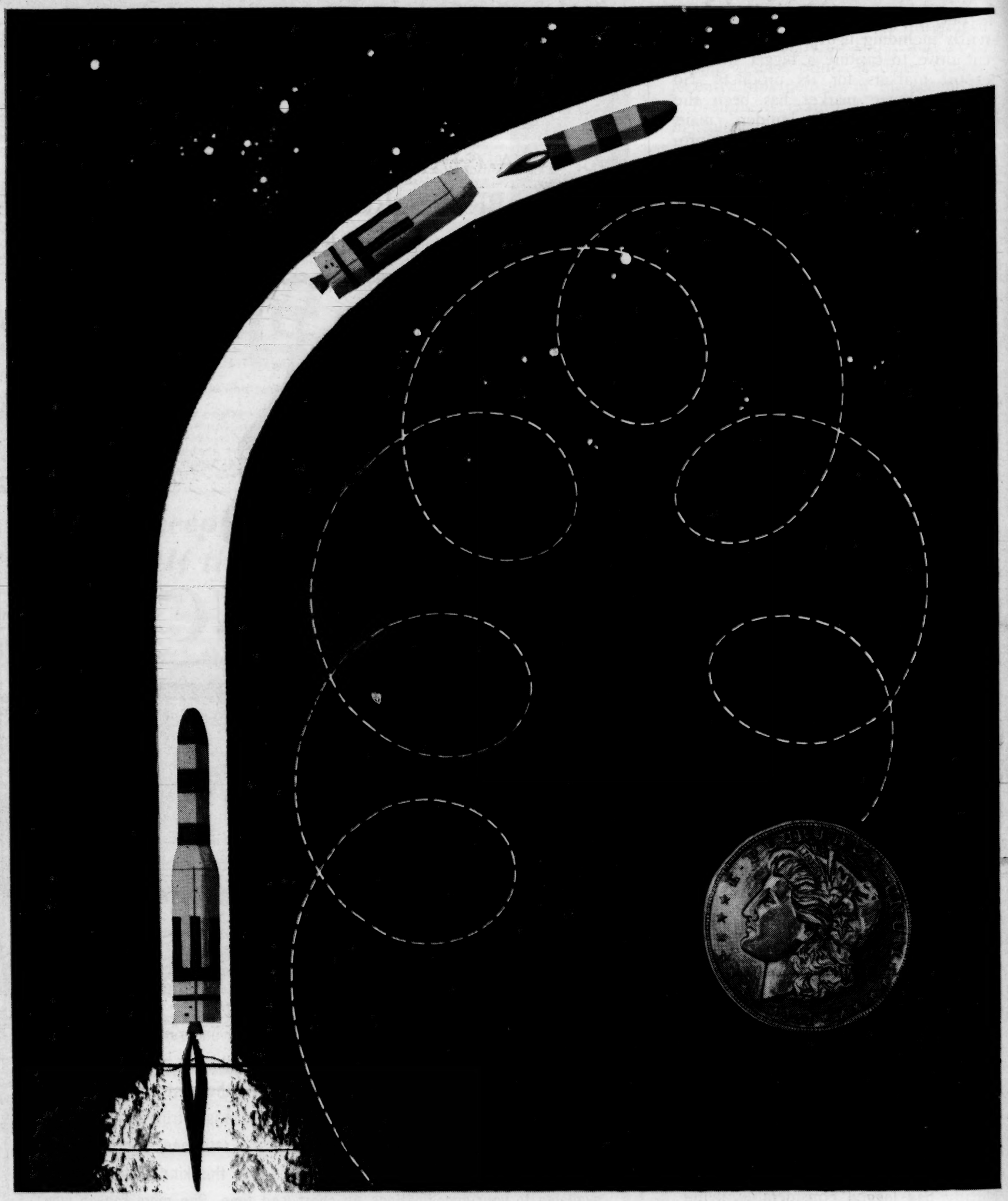
EVIDENCE



Extremely low bench error. Only slightly greater error under maximum environmental conditions. That's the story told on the graph. And by the operational success of this Giannini product in flight. It's the best way we know of to measure a pressure ratio, whether the application is a true air speed indicator, static source compensator, engine pressure ratio sensor, mach transducer, or you name it. Instrument systems with this kind of performance available to your specifications on short lead time. One more reason why you hear it said: **When it's from Giannini you get it on time, it works when you get it, and it keeps on working.** Send for technical bulletin GTN 360.

Giannini Controls Corporation
A NAME TO PLAN WITH
1600 South Mountain Avenue, Duarte, California
SERVO COMPONENTS & SYSTEMS • AIR DATA INSTRUMENTS & SYSTEMS
INERTIAL INSTRUMENTS & SYSTEMS
Sales engineering offices: Pasadena • Palo Alto • Seattle • New York • Chicago • Dayton • Washington
GCC 1-18

Circle Number 269 on Reader-Service Card



BUT, MONSIEUR BERTRAND, OUR COINS HAVE MEMORIES!

You said, "A coin has neither a memory nor a conscience." The reliability of our inertial guidance systems depends on their having both. Thus our reliability engineers must go beyond your venerable formulae in developing dependable guidance packages for missiles like Titan.

If the application of existing theory into usable reality challenges you, and if you have a BS, MS or PhD in EE, ME, Physics or Math, please contact Mr. F. A. Allen, Director of Scientific and Professional Employment, 7929 S. Howell, Milwaukee 1, Wisconsin.

AC SPARK PLUG ❀ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Britain Eyes Competitive Project Cuts

By John Tunstall

London—Steps to eliminate duplication in current and future civil aircraft projects appear to be under way by Britain's two airframe groups, Hawker Siddeley and British Aircraft Corp. The move is seen as an attempt to combat strong U.S. competition and jointly, at least, to stay in the transport business in all major categories.

It could lead to a similar move between the two major engine companies, avoiding in the first case, conflict in the important middle engine categories around 7,000 lb. thrust. State of the world engine market has already been called "a battle for survival" by Rolls-Royce.

First evidence of this liaison between airframe groups is likely to show in production decisions affecting the Vickers VC 11, the de Havilland 121 Trident, the BAC 107 and the Avro 771.

Special Committee

The move appears to have been initiated by Hawker Siddeley and to be the outcome of its recently formed Committee of Advanced Study. The object of this body was specifically to eliminate competition not only between the group's own subsidiary companies but also between the two groups themselves.

Need to avoid head-on conflict between the groups had seemed to most observers one of the most essential objectives of last year's regrouping operation.

Early this year such a head-on conflict in two aircraft categories became imminent. In the short-range category, BAC was developing the BAC 107 feeder liner and the Avro 771, both aircraft embodying the same Bristol Siddeley BS 75 rear engine configuration. In the medium range category BAC, impressed with the size of the market, was developing the Vickers VC 11, thus extending the struggle in the long-range area into medium range categories as well.

In this field the DH 121 and the Boeing 727 were already committed to production.

Goodwill Effort

Indications were that Hawker would continue with the Trident and drop the Avro 770 and Vickers would abandon the VC 11 and expedite the BAC 107 in the hope of exploiting the goodwill of its several hundred Viscount customers.

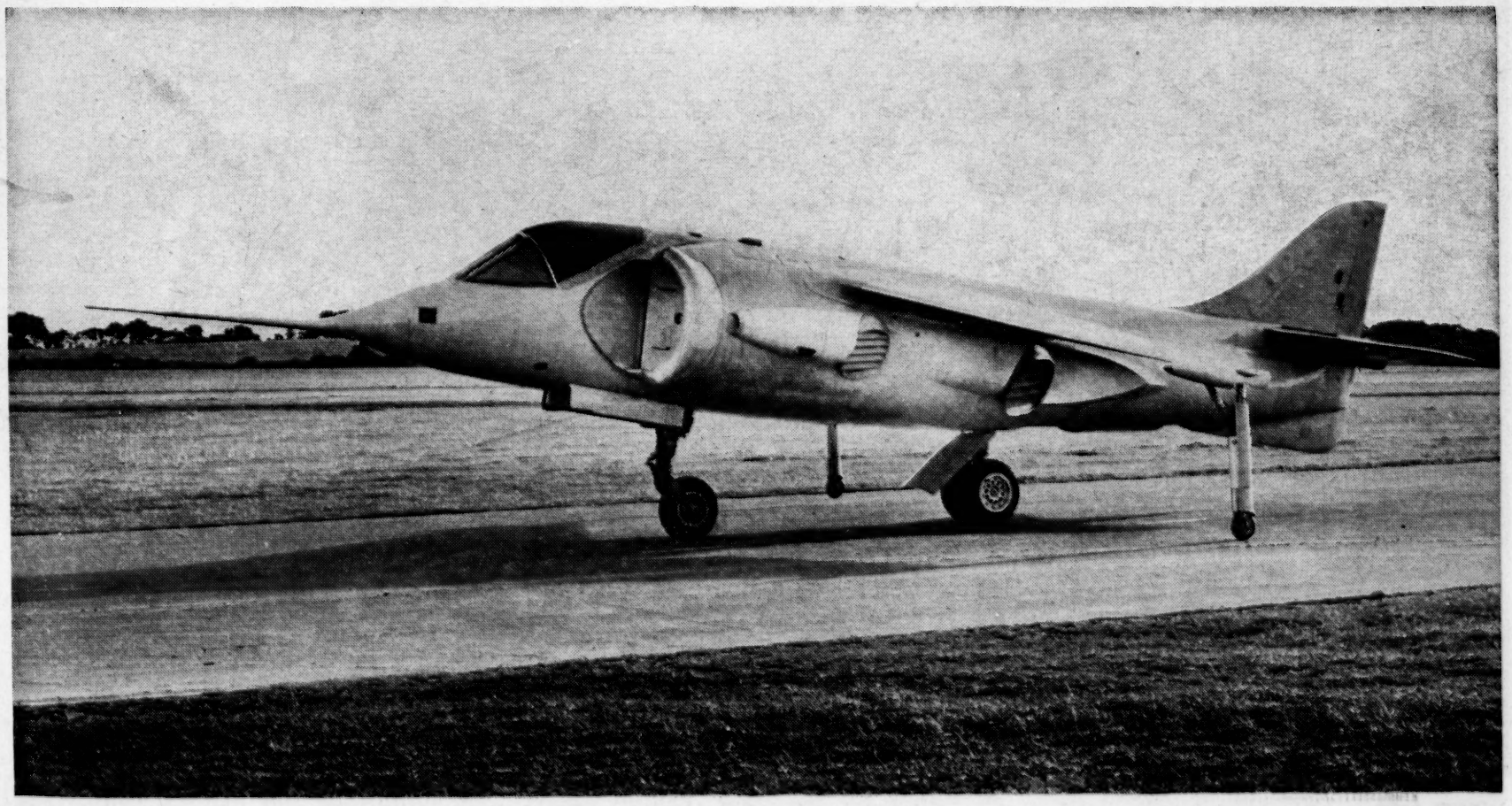
Such a move would certainly have government blessing and would most likely lead to a substantial and immediate military order for the BAC 107 as a VIP transport replacement for the Vickers Varsity. No order for such a replacement is likely until the government sees a civil aircraft emerge with realistic commercial prospects that are capable of adaptation.

Possibilities for Avro appeared to lie in developing an aircraft between the feeder liner of 50,000 lb. gross weight and the jet executive of about 20,000 lb. by the scaling the 771 down. More likely was the prospect that Hawker Siddeley would farm out a small turbofan executive aircraft grossing 20,000 lb. which was well advanced on the drawing boards at de Havilland. An aft-fan conversion of the Viper turbojet engine was being prepared by Bristol Siddeley for such an aircraft category and Bristol aims to have it in service by 1963.

Top Priority Effort

Hawker Siddeley, anticipating the Boeing 727 decision, mounted a top priority group effort on the Trident to advance the completion date. At least four aircraft are now believed to be an advanced stage and the first flight may be as much as three months ahead of the original December date.

De Havilland emphasized that it had no intention to duplicate the Boeing 727 size, maintaining that the medium range bracket is wide enough to accommodate two aircraft sizes. "We feel that the 140,000 lb. of the Boeing 727 is perfectly sensible for the U.S. market, but that the Trident weight is closer to the requirements



HAWKER P 1127 VTOL

of other world airlines which have been good British customers in the past," de Havilland said.

An initial batch of seven Trident aircraft had been authorized and certification was originally scheduled for the winter of 1963. The Trident is basically a 105,000-lb. airplane designed for 1,000-mi. stage lengths but it has since been stressed to gross 112,000 lb. in order to carry its same 20,000-lb. payload but with another 1,200 gal. of fuel stowed into the wing center section. The stretched version can thus operate up to medium stages of 1,500 mi.

In spite of the collaboration movement between the groups, Sir George Edwards, executive director-aircraft for BAC, still appeared determined to, take the plunge with the VC 11 if a substantial order from either of two interested U. S. airlines for the airplane materialized soon enough.

Commenting on the merger operation, Sir George said that BAC had adopted a closely integrated structure compatible with each company giving birth to its own projects, followed by group augmentation. He thought this would give the best of both worlds. The isolation inherent in creating an advanced projects group, he feared, could lead to an ivory tower complex.

It was known that Vickers has been on the threshold of a critical production decision for some time involving the VC 11 and the BAC 107. Sir George told AVIATION WEEK that the problem was not one of capacity but finance, and he doubted whether this could be arranged to cover both aircraft. Capacity, he said, could be found quite easily by utilizing Bristol's floor space.

De Havilland has already been officially assured of government help in the manufacture of the Trident. No details of this support have been disclosed but the company reportedly can now proceed with the manufacture of the aircraft off the shelf almost up to its breakeven number, taking into account the BEA order already on the books for 23 aircraft.

Sales Disappoint

In spite of a near peak export sales figure of $398 million and a labor force only 9% down from the 1956 peak level, the industry was starkly aware that it still had to break through with all its major new civil aircraft. Of the 35 new aircraft orders last year, 23 were Comets and 13 were Viscounts.

Engine group prospects were bound closely to the British airframe situation in spite of Bristol and Rolls sales to NATO, Japan, and to the first generation of American jets. Both companies realized that sales would get much tougher, when U.S. and British manufacturers were both competing in 1963 with the second generation of bypass or turbofan engines.

Last year's engine sales reached a new peak of $200 million which was more than half the total export figure. Current sales totals include Armstrong Whitworth Argosy, 63; Avro 748,11; DH Trident, 24; Comet, 63; Herald, 13; Vanguard, 43; VC 10 family, 48.

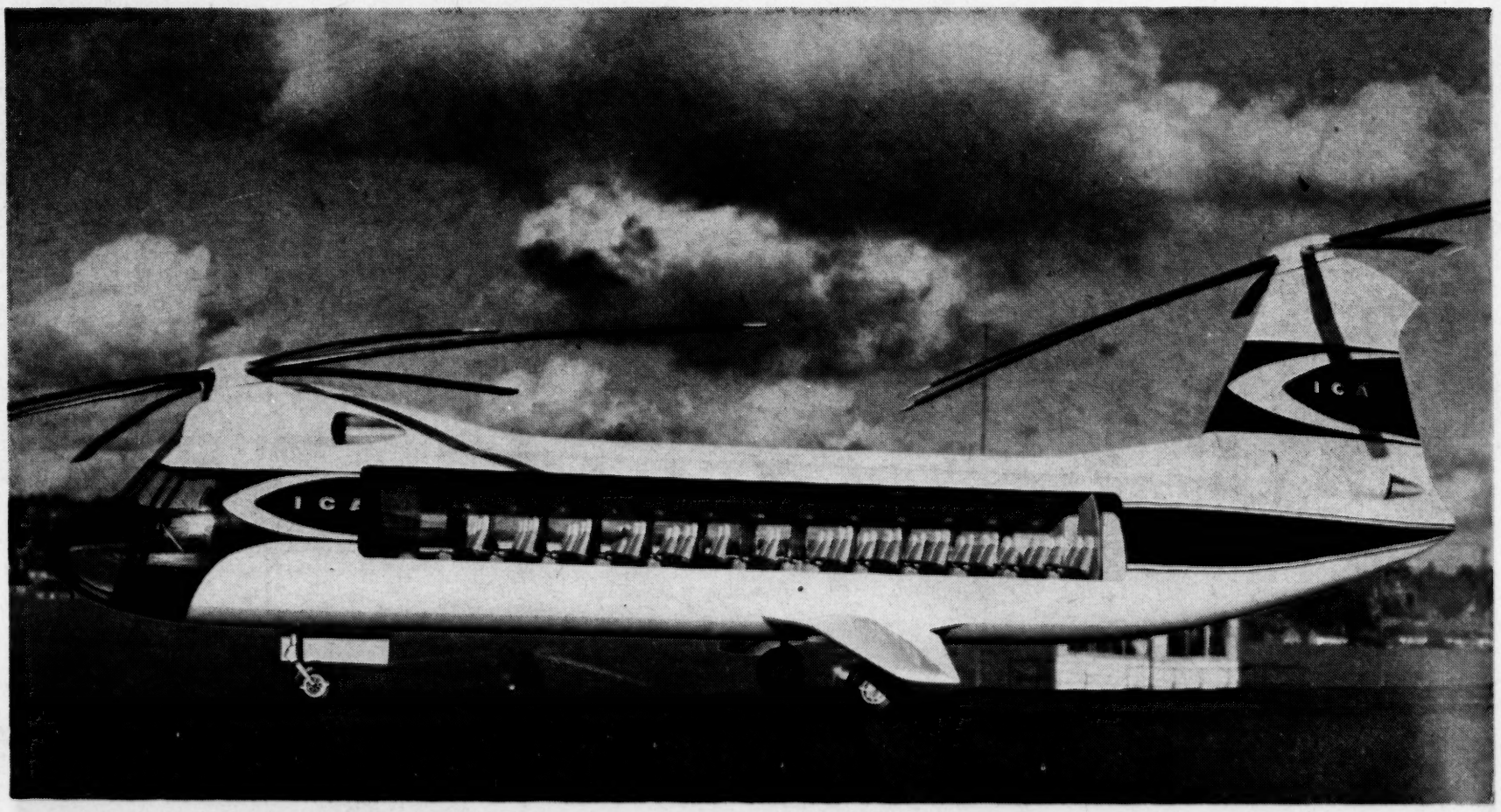
In the Hawker Siddeley group Avro, de Havilland and Armstrong Whitworth were at peak postwar employment levels.

A reassessment of the Comet's prospects has also shown that future sales potential is better than was believed last year. De Havilland expects to go on selling this transport for a further two years and gain 20 more orders. The group is directing its sales effort at the smaller operators in the Middle East, Far East, Central and South America, who need a smaller aircraft.

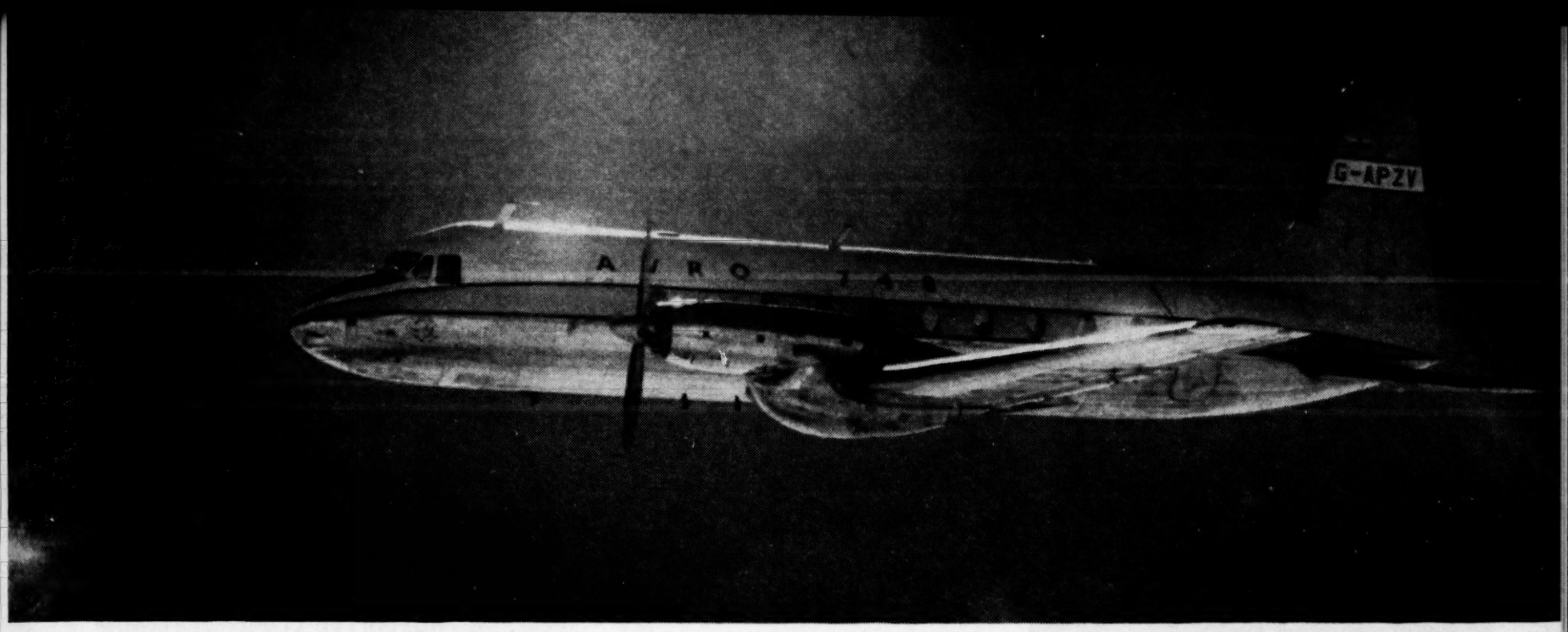
Argosy and Seaslug production has pushed Armstrong Whitworth's labor force to 11,000—a postwar peak. With 56 military orders for the first Argosy 660 C Mark 1 and the first 10 civil aircraft allocated, Armstrong has virtually reached the breakeven number, but the company is not overlooking the fact that it has still to break through in the civil freight market for which the Argosy was designed.

The first 10 civil airplanes which were authorized without an order on the books have now flown. Seven went to Riddle Airlines in the U.S. Negotiations were under way with British European Airways to purchase the other three, and at that time also, Hawker management was preparing to authorize production of a further 10 civil Argosies without orders to prevent the materials pipeline from running out. On the military order, 10 fuselages were already complete and production is likely to reach four a month.

Armstrong Whitworth had no new major civil projects in hand but the



WESTLAND model shows interior configuration of its stub wing Belvedere transport helicopter.



AVRO 748 TRANSPORT

company has plans to modify the AW 671 airbus version of the Argosy to accommodate more cars and fewer passengers.

Avro is working at peak employment on the Vulcan bomber, the Blue Steel air launched missile and the Avro 748. The Mark II Vulcan now in squadron service as the spearhead of the Royal Air Force re-equipment program is in full production. Blue Steel, now in the middle of its trials program, is being produced in substantial quantities.

Costly Fire

Flight development program of the 748 feeder liner was set back four to six months by the extensive fire at Avro's Manchester factory when the roof collapsed on the second prototype. Certification is not expected until April. Maiden flight of the second prototype is expected this month, and 300 hr. of flight testing in the first aircraft has been mostly trouble free. The actual production program was not interrupted and the first of six aircraft now being equipped is expected to fly in June.

There have been 11 sales and an order for 10 was awaiting ratification with an undisclosed customer early this year. J. A. R. Kay, newly appointed sales director of Hawker Siddeley, said he was confident of at least 46 civil sales within the next two years, notably to operators in South America, the Caribbean area and Africa. Projected versions of the 748 are all based on the low wing configuration and interest in the high wing military project appears to have lapsed.

Vickers found 1960 a disappointment not only for lack of new orders but also because of metallurgical problems with engines and airframes that grounded the Vanguard on the eve of certification and at one time threatened to ground many 700 series Viscounts.

To meet a small but continuing requirement, Vickers will make the Viscounts for stock at the rate of one a month. The Viscount assembly line, which reached a peak production of 26 aircraft a month, has now been allocated to the VC 10. Very shortly provision will be made for the TSR 2 production line.

A contract for a preproduction batch of this nuclear strike aircraft was awarded in October.

Vickers is determined to extend production of the Vanguard into 1962. Production requirements of the VC 10 may then be allowed to encroach on the Vanguard line, but Sir George Edwards said there was nothing to stop BAC from setting up the jigs at Bristol if any interest in the aircraft survived. "Obviously we would not do it for four or five aircraft," he said. He hinted that a long-planned military version of the aircraft was not entirely dead.

The Tyne compressor and turbine disk problem jeopardized at least 20 sales which were almost clinched prior to the grounding, Sir George said.

Hopes for the VC 10 were pinned on airlines which are not yet committed to big jets.

Negotiations Under Way

Negotiations were under way between the company and BOAC to abandon the Super VC 10 and replace it with a smaller aircraft which would normally have emerged as a Mk.II version of the VC 10. Fuselage of the new airplane is the same as that of the VC 10 and the new passenger capacity has been achieved by extending the cabin 5 ft. back by relocating engine bearers and a 20-in. encroachment on the front cockpit. The BOAC order was likely to be revised in the light of the new specification to include fewer VC 10 and more of the later airplane.

Westland, now Britain's sole helicopter builder, says that the policy of submerging identities of the acquired groups—Bristol, Fairey, Saunders-Roe—has worked well.

A Bristol transport helicopter configuration, the Belvedere, has become a favored prospect displacing Westland's own Westminister and the Fairey Rotodyne. The Westminister has, in fact, been dropped entirely and the Rotodyne appears to have little priority. Although proposals based on all three transport helicopters have been submitted to the government, the company is clearly pushing stub wing variants of the Belvedere. However, Westland maintains that it is beyond its financial and technical capacity to launch into production a medium-size transport helicopter without substantial government support.

Belvedere Concept

The tandem-rotor Belvedere was originally developed with twin Leonides piston engines for the Royal Navy with the designation 171. It was re-engined with Gazelle turbines and structurally modified for the Royal Air Force under the designation 192.

The order for the Navy version which was canceled in favor of the Wessex was believed to have been for about 100 aircraft.

The current Royal Air Force requirement, although substantial, is less than half that.

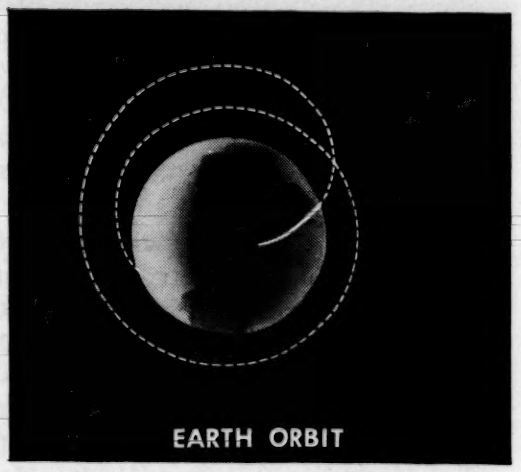
The Westland 194 stub wing version which has been submitted to the Ministry is a 50-seat version, retaining the tandem-rotor configuration, but having twin de Havilland Gnome turboshaft engines at either end. The wing span is 40 ft. and the wing provides pitch stabilization as well as substantially unloading the rotor during cruise. The fuselage is being lengthened to 80 ft. and deepened to improve the seating arrangements.

Westland is also pushing a 23 seat civil version of the Belvedere 192C as

PIONEERING IS OUR BUSINESS

NEWS about advanced Bendix® research in space environment systems

Providing an environment in which man can continue to exist, live, and breathe, as required for each new generation of space vehicles, is well on the way to accomplishment at Pioneer-Central. This brief look at what we are doing to help solve key space environment problems reflects only one phase of our total pioneering research activities.

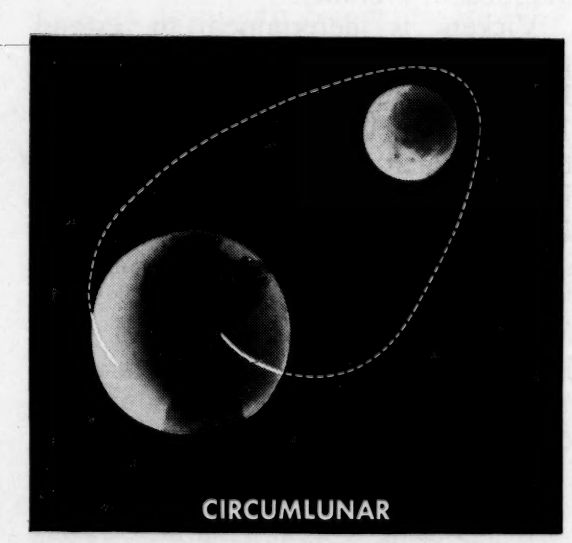


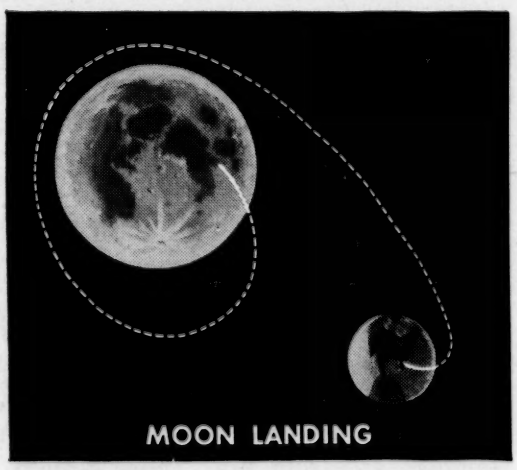
FIRST GENERATION:

This closed atmosphere Bendix system will supply a man with breathing oxygen, dispose of his respired carbon dioxide, and completely ventilate and condition his environment. Soon to be ready for check-out by Air Force team on high-altitude jet aircraft prior to ultimate use on manned space vehicles.

SECOND GENERATION:

Here a Bendix individual space environment system is also nearing completion. It is self-powered and controlled by man's metabolic processes. Oxygen is supplied by either super-oxides or a zero "G" liquid gas converter—both of which are now being developed by Pioneer-Central.





THIRD GENERATION:

Involved here is the use of algae for atmosphere control in a closed ecology system. Algae can maintain a compatible atmosphere for long periods, can be applied to orbital and lunar research stations, and are applicable to converting man's waste products into man's body necessities. Our system—now in the development stage—will convert the respiratory waste products into reusable breathing oxygen.

QUALIFIED ENGINEERS ARE INVITED TO INVESTIGATE THE MANY OPPORTUNITIES AT:

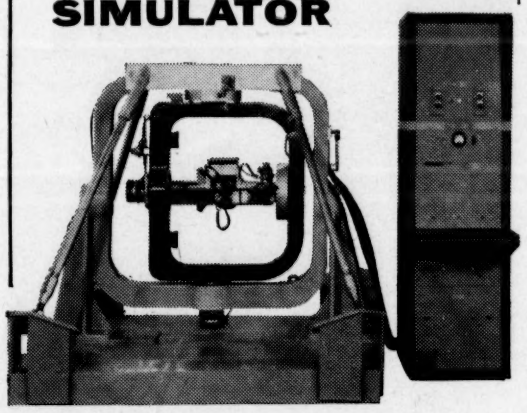
Pioneer-Central Division
HICKORY GROVE ROAD
DAVENPORT, IOWA

West Coast Sales and Service, Burbank, Calif.
Bendix International Division, 205 E. 42nd St., New York, N. Y.
Aviation Electric, Ltd., Montreal, Quebec, Canada

THE Bendix CORPORATION

Circle Number 276 on Reader-Service Card

3-AXIS FLIGHT SIMULATOR



A CONTROLLED FLIGHT PLATFORM IN YOUR LABORATORY ASSURES SYSTEM ACCURACY AND STABILITY

- **Creates identical dynamic motion of missiles and aircraft.**
- **Unequaled in range of smooth, dynamic performance.**
- **Large volume, high inertia loads evaluated at minimum cost and maintenance.**

Evaluation and testing of guidance systems, including their stabilization and control unit, can be performed conveniently and easily under controlled, laboratory conditions. When used in conjunction with an analog computer, the Model 140 Flight Simulator subjects the angular-position and angular-motion-sensing instruments of the guidance unit to the same dynamic motions encountered in flight of the actual missile or high-performance aircraft. This type of simulation, using the actual control components under identical flight conditions, assures accuracy and stability of the control system in flight performance.

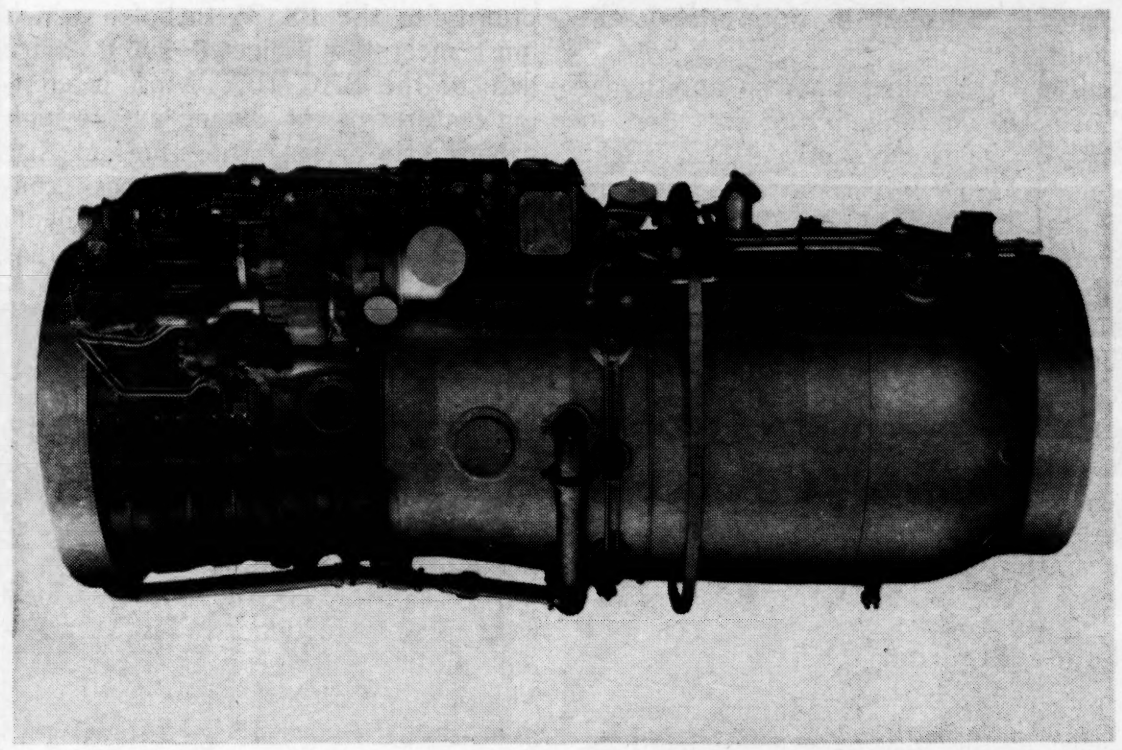
The Model 140 Simulator consists of three hydraulically-driven gimbals that translate computer or other signal-source voltages into roll, pitch, and yaw positions, velocities, and accelerations by means of a position-feedback servo system. One of the most important features of the Model 140 Flight Simulator is the extremely high ratio of maximum-to-minimum, smooth, controlled rates.

Write for full information

CTI®
CALIFORNIA TECHNICAL INDUSTRIES
DIVISION OF TEXTRON INC.
BELMONT 2, CALIFORNIA

Foremost in Automatic Testing

Circle Number 274 on Reader-Service Card



ROLLS-ROYCE R.B. 163 Spey bypass engine.

an interim machine for BEA's Scilly Isle route and for reputedly new requirement for a service between Gatwick and London. This version which could be in service by 1963 has also been submitted to the Ministry of Aviation but again this is as far as the company intends to go without support from BEA.

Belvedere production will continue at the Bristol division but Saunders Roe P. 531 Scout production will be transferred to Fairey's factory at Hayes. Skeeter, Sycamore, and Widgeon production has ceased. Wessex 1 production—a Gazelle-engined Sikorsky S-58—continues at Yeovil on what is generally believed to be the largest helicopter order Westland has received. A Mk. II version of the Wessex is being developed for the RAF, powered by two Gnomes instead of a single Gazelle. Full production is also being maintained on the Whirlwind and on the conversion of existing airframes to the Gnome turbine.

Sales Campaign

Westland has always insisted that Fairey overpublicized the readiness of the Rotodyne concept in its sales campaign. In spite of now having accepted responsibility for the government's $12 million grant to continue its development, the company shows little enthusiasm for the project, at least as a commercial venture, on both noise and control grounds, and it does not propose to produce the Rotodyne unless a substantial military contract for the aircraft is assured.

Westland has submitted a tender to the Minister of Aviation for 12 Rotodynes for Transport Command, promising full military certification for service in 1964. Discussions with BEA were also proceeding, the company said, on a tentative basis to provide six aircraft for 1965 delivery. The New York Airways letter of intent for five with an option on 15, and the U. S. licensing arrangement with Kaman Aircraft still stand.

V/STOL Efforts

The view is widely held in Britain that there are enough runways in Europe to make VTOL and STOL aircraft a purely military requirement. Civil application—probably long-range freighters—is a long term possibility if proven militarily. Emphasis is on STOL subsonic transports with the exception of the P 1127.

Apart from the Short SC. 1 experimental aircraft, design study nearest to development is an Argosy conversion. The Argosy project employs a cluster of 15-20 Rolls-Royce 108 turbojets, depending probably on the version of engine available. The lift engines will be located in the outer engine nacelles, and Tyne turboprops in the inboard nacelles would replace the four Darts currently used.

Both Rolls and Bristol lift-engine developments probably have thrust-to weight ratios of 14:1 to 16:1, clearly indicating thrust augmentation by some form of fan configuration. Also indicated is use of plastic reinforced inlet and first stage compressor blading and parts of the casing.

Based on the availability of large turbofans, the P 1127 illustrates a second British approach, considered by Hawker to be best for aircraft where cruise thrust exceeds the weight. Deflection of the fan and jet effluxes through lightweight plastic deflector nozzles as on the BS 53, gives the aircraft VTOL capability without the parasitic weight penalty of separate lift engines and enabling the sole power

Fast Shipment FROM WORLD'S LARGEST STOCK of STAINLESS STEEL AN—MS COMMERCIAL BOLTS

SCREWS—Complete range of machine and self tapping with slotted or Phillips recessed heads, both magnetic and non-magnetic.

NUTS—Cap, Hex, Castle, Slotted, Square, Wing, etc.

PINS—dowel, taper, etc. Plus washers, rivets, threaded rod, studs, nails, many more.

"SPECIALS"—fabricated to your specs on extremely short notice.

WRITE • WIRE • PHONE

FOR QUOTATION OR SHIPMENT ASK FOR CATALOG

ALLMETAL®

Screw Products Company, Inc.

Manufacturers of Stainless Fasteners Since 1929

821 Stewart Avenue, Garden City, L.I., N.Y.
Phone: Ploneer 1-1200 TWX GCY 603

Midwest Division
6424 W. Belmont Avenue, Chicago 34, Illinois
Phone: AVenue 2-3232 TWX CG 3185

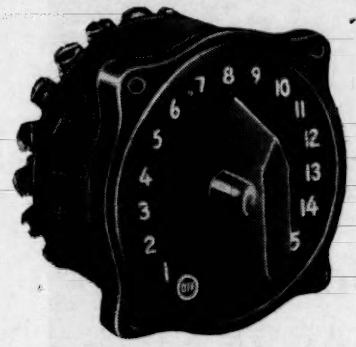
West Coast Division—Office and Warehouse
5822 West Washington Blvd., Culver City, Calif.
Phone: WEbster 3-9595 TWX LA 1472

Circle Number 277 on Reader-Service Card

LEWIS

SELECTOR SWITCHES
for
▸ Resistance Thermometers
▸ Thermocouple Thermometers

THERMOCOUPLE SWITCHES



Flanged Cases
in 2 inch
3 inch
4 inch dia.

Engineered to give years of service in test work as well as in permanent installations, LEWIS switches have heavy, low-resistance contacts; positive detent action and sturdy terminals for easy wiring.

The cases are splash proof and dust tight, of close fitting bakelite. Husky black-finished aluminum indexing knobs are used to turn the stainless steel shaft supporting the rotating brushes.

RESISTANCE BULB SWITCHES

A companion line of the same construction except that they are fitted with a common-terminal ring for three-wire bulb connections.

THE 9S SERIES
THE SPACE SAVERS

FOR AIRCRAFT RESISTANCE THERMOMETERS

1¼" dia.

Small, sturdy, steel-cased switches 1¼ inches in diameter, 2-9/32 inches total shaft length, one hole mounting with ½-32 NS-2A threaded bushing. Designed especially for connecting two or more resistance temperature detectors to one instrument, now flying in the modern jets.

Write for our descriptive bulletin on Selector Switches

The LEWIS ENGINEERING CO.
Specialists In Temperature Measurement
NAUGATUCK, CONNECTICUT

Circle Number 278 on Reader-Service Card

plant to cruise at its optimum design point.

The P 1127 first made an untethered hover in December, and was due to make its maiden conventional flight this month with transistion soon to follow. The P 1127 airframe is subsonic and will have the disadvantage of cruising fairly heavily throttled. But Bristol says the BS 53 with afterburner needs only blade and disk metal changes to give the engine supersonic capability. A single horizontal engine has maintenance advantages, says Bristol. Capability to vector its vertical lift gives the aircraft better STOL characteristics when operating with an extra load.

Space Program

1960 saw a significant improvement in the space program climate in Britain as the emergence of commercial prospects raised the emphasis from just space research to the exploitation of space. Especially encouraging to Geoffrey Pardoe, who heads the Blue Streak team, was the healing of the breach between two opposed groups of scientists who viewed differently the merits of a British launching vehicle and certain aspects of space research itself.

Some influential sources still remain critical of the government's tactics in last year's campaign to solicit Commonwealth and European cooperation. Britain might have been more successful had she first made the decision to continue Blue Streak, they believe.

A weakness of the proposal also appears to have been lack of a central authority empowered to take an over-all point of view on space exploitation and decide on scientific and industrial emphasis and priorities. "A general appraisal of the over-all space situation still has not been properly or intelligently made in Britain," Pardoe said. Particularly overdue, he thought, was a statement from the British Post Office authorities who are investigating space communications.

Improbable Development

Following announcement in the House of Commons that the feasibility of using a French vehicle for the second stage instead of Black Knight had been established, reports suggested that this vehicle would be a derivative of the Veronique. British experts regard this development as improbable since the Veronique, despite a superior propulsion system, would require too much development to bring it to comparable Black Knight performance. British engineers believe the French government has other rocket developments closer to Black Knight performance.

Bristol Siddeley recently gave top priority to the BS 75 turbofan which must meet the projected 1963 service date of the BAC 107. Most interesting features of the engine are its high bypass ratio or fan ratio; the fact that it achieves an optimum bypass configuration with scaled rotor components from proven engines, and that it has the lowest projected cruise specific fuel consumption of any such engine—0.76 lb./hr./lb.

Bristol Siddeley says that intensive development of the Olympus engine for the TSR 2 is proceeding. This engine is believed to be a close derivative thermodynamically and mechanically of the current production engine, the Olympus Mk. 21 300 series, which went into production late last year giving thrusts in excess of 20,000 lb. Modifications are not likely to be more than those needed to give an engine supersonic capability, i.e. change of material in the compressor blading and disks to accommodate the higher compression temperatures and the associated higher temperatures of the air available for disk cooling.

Much of the development effort on the TSR 2 engine at Bristol and the National Gas Turbine Establishment is believed to involve variable intake and variable nozzle configurations. A special feature of the engine, due to the unusual flight envelope, will be an advanced automatic fuel and propulsion control system.

With this propulsion installation, Bristol believes it has the thrust requirement and engine control sophistication needed for the British supersonic airliner Mach 2 project.

Swallow Project

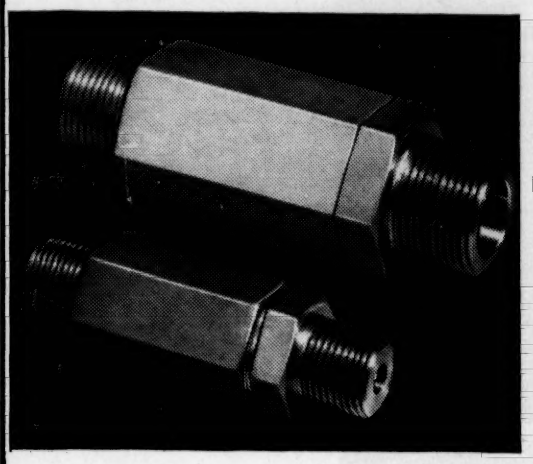
The Swallow project was proceeding, but any adoption of the Barnes-Wallis variable wing geometry concept for either a civil or military role will show some fairly radical departures. The project now being developed may no longer have ball-jointed engines at the wing tips.

These would be mounted on the rear fuselage, and other methods of controlling the aircraft established.

Last year saw the birth of a ground effect machine industry in Britain in the formation of a light-aircraft group under Peter Masefield and named the British Executive and General Aviation Group, (Beagle).

Saunders-Roe is currently building an operational development of the original Cockerell experimental SRN 1, weighing 28 tons and considered by Cockerell to be about the minimum size. The SRN 2 will carry 70 passengers and cruise at 70 kt. It's designed for the sea/ferry role and is powered by four Blackburn Nimbus turboprops with reverse pitch braking.

KOHLER PRECISION CONTROLS



New high pressure, in-line, relief valves with low hysteresis

MATERIAL—Aluminum, Steel, Stainless Steel
CONNECTIONS—All Types
WORKING PRESSURE—1500 to 3000 PSI
PROOF PRESSURE—2250 to 4500 PSI
BURST PRESSURE—3750 to 7500 PSI
OPENING PRESSURE—0 to 2250 PSI
RESEAT PRESSURE—10% Below Opening Pressure
LEAKAGE—0 at Reseat Pressure

• • • • • • • •

Ultra-sonic cleaning facilities. Kohler valves and other precision parts are assembled, tested, and packaged in dust controlled areas for minimum contamination.

Complete facilities in one plant, under unified supervision, insure reliable quality control and prompt deliveries. Kohler valves, fittings and parts are used by leading manufacturers for industrial equipment, automotive, aircraft and missile applications. Write for catalog.

Kohler Co. *Established 1873*
Kohler, Wis.

KOHLER OF KOHLER

Enameled Iron and Vitreous China Plumbing Fixtures • All-Brass Fittings • Electric Plants Air-Cooled Engines • Precision Controls

Circle Number 275 on Reader-Service Card

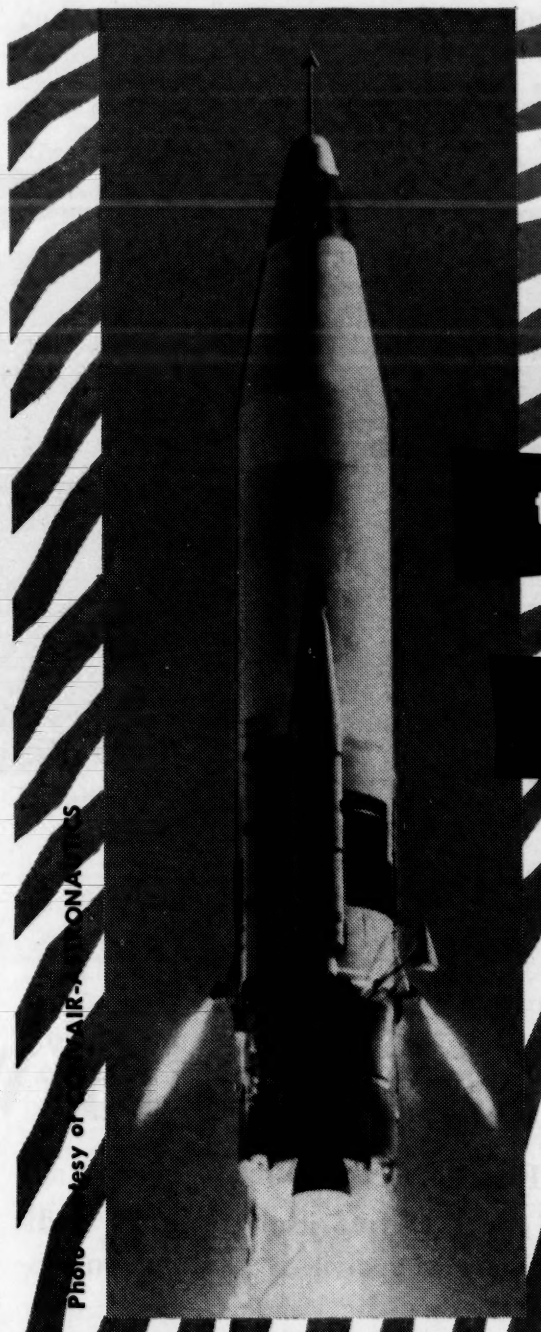


Photo courtesy of [illegible] AIR-[illegible]ONAUTICS

expanding the image of infinity

The superior grades of Carlson stainless steel plate are ideally suited for many air-space applications. With 17-4 PH, 17-7 PH and PH15-7 Mo*, for example, it is possible to attain the high physical properties and resistance to elevated temperatures required in space flight engineering. Other grades can be rolled to your order by Carlson to provide special fabricating and in-service advantages that are equally important.

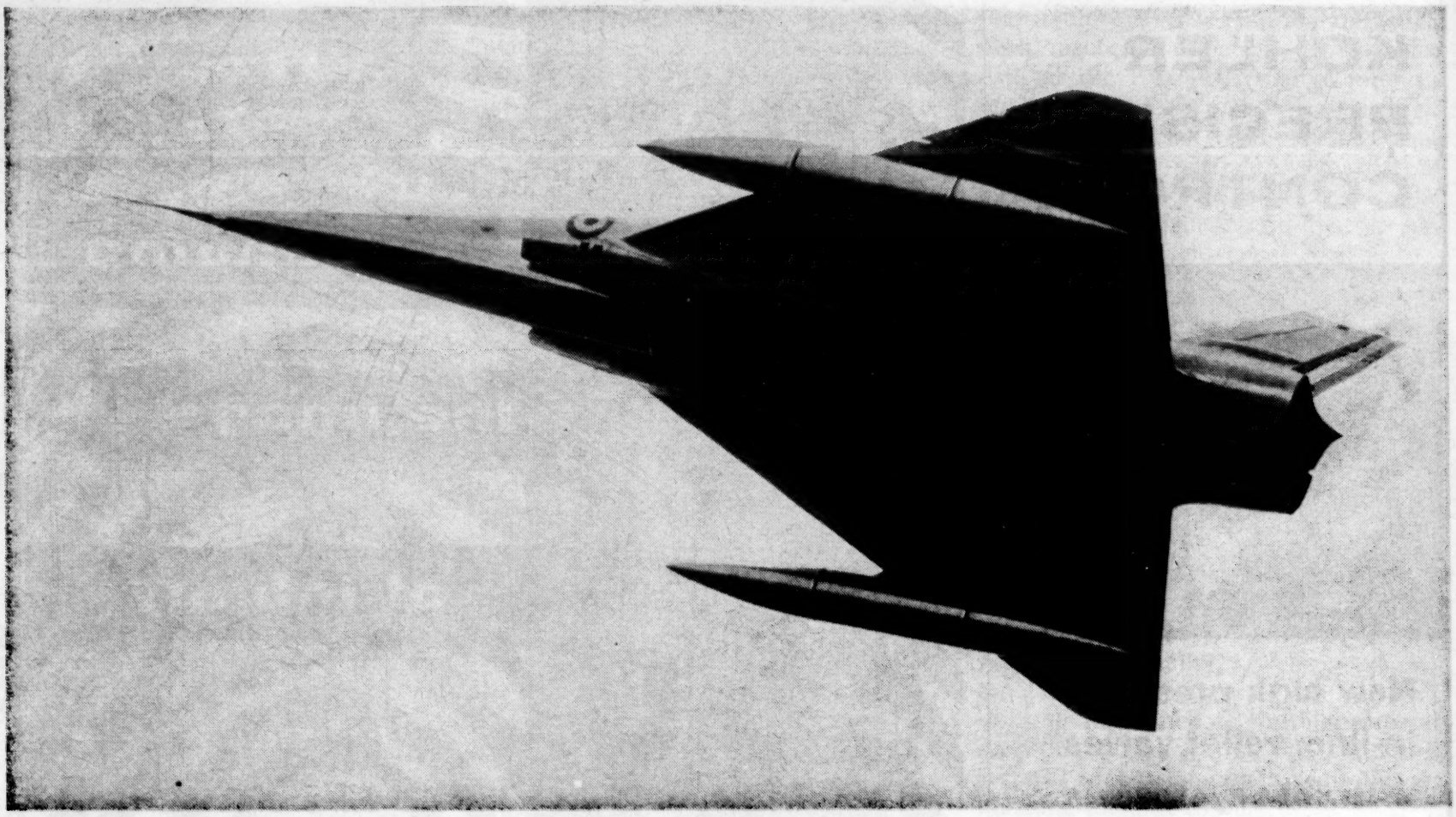
You can count on our "exclusively stainless" team. It will bring you the finest personalized service and on-schedule delivery of superior and standard grades of stainless steel plate and other stainless products. Write, wire or phone for action!

**Precipitation-hardening grades, trademarks of Armco Steel Corp.*

G.O.CARLSON Inc.
Producers of Stainless Steel

151 Marshallton Road
THORNDALE, PENNSYLVANIA
District Sales Offices in Principal Cities

Circle Number 279 on Reader-Service Card



DASSAULT MIRAGE IV BOMBER

French Score in Drive to Widen Market

By Robert Farrell

French aircraft industry's determined effort to free itself from its traditional dependence on French buyers—military and civil—is yielding impressive results.

A breakdown of the industry's 1960 sales figures of $440 million—up $60 million from previous year—shows that 42% represented export sales. In 1959, export sales accounted for only 21% of total industry business. This year export business may go over the 50% mark.

Sud Aviation's steady export success with its twin-jet Caravelle transport can't take all the credit. Caravelle sales made up 40% of the industry's 1960 export business. Balance was a variety of French airframes, engines and equipment along with Sud's brisk-selling Alouette helicopter and Nord Aviation's family of tactical and target missiles.

Mirage Successes

Moreover, 1960 export figures don't reflect year-end success of Avions Dassault in selling its Mirage III delta-wing interceptor to the Australian and Swiss air forces. These sales, as well as export possibilities for the Mirage in India and elsewhere, are helping to offset French disappointment over the Mirage's lack of acceptance by European NATO powers.

Talks with French industry officials clearly reflect an "export psychology," not just among the larger companies but throughout the industry. This attitude has even affected industry's approach to the lightplane market. French small aircraft building traditionally has been artisan in nature, with the home market the small builder's main concern. Now several companies are designing light aircraft to be sold and serviced in an international market.

When Morane-Saulnier last summer launched a sales campaign for its all-metal, three-seater sports plane, the MS 880 Rallye, it did so on an international scale. At year-end, Morane, having booked 76 orders from 16 foreign countries along with 74 French orders, began planning to turn out 30 Rallyes per month, a light plane production rate which has never before been undertaken in France.

Morane, significantly, has exported more of its twin-jet executive aircraft, the MS 760 Paris, than it has sold to French customers. This experience probably convinced Morane that its future depends, as the future of the entire industry does, on its success in a world and not just a French market.

Another aspect of industry's new export attitude is its orientation toward cooperation with non-French companies on new projects. French initiative in this field already has led to acceptance of French designs in two major west European projects:

- **Breguet's Atlantic** twin-turboprop ASW project for NATO, which involves the U. S. and four European members.
- **Nord's** twin-turboprop cargo aircraft, the C-160 Transall, being built jointly by France and West Germany.

France, having quietly dropped its VTOL work centered on Snecma's Flying Atar Coleopter design, now is working with a West German group on a high-performance VTOL fighter.

Wider cooperation with foreign groups is considered the only way French industry can participate in a comprehensive space effort. Current five-year, non-military French space program is budgeted at only $26 million. Newly formed French Committee on Space Research, headed by Professor Pierre Auger, has outlined a modest initial program to cost $8.4 million. Of this amount only $3.3 million of credits has been authorized.

Space Probes

French Space Committee's initial program doesn't include a satellite. Instead, the committee expects to launch 20 rocket probes this year, including five of France's standard research rocket, the 21-ft. Veronique. Firings will be used in studies of propagation of electromagnetic waves at high altitudes and for

gathering a variety of data on the ionosphere.

French are keenly interested in expanding their national effort by cooperative space projects with other nations. They are negotiating with the U. S. on a space venture similar to those Washington plans with Great Britain and Canada. One proposal calls for a Chance Vought-NASA Scout missile to boost a French instrument payload into orbit next year. Final agreement may be signed this month.

Also of interest to France is work with NASA on a satellite communications network between the U. S. and Western Europe. At same time the French are playing major roles in various European cooperative space schemes, not yet settled.

One would use Britain's Blue Streak with France's Veronique as a European space booster.

Space Cooperation

Despite their ambitions, the French may have to decide between these various international projects, rather than spread their space effort too thin. In this case, it's likely the French will choose space cooperation with NASA, providing aid offered is wrapped in attractive terms.

Obviously French space effort will be affected by the government's plan to develop an independent nuclear strike force based initially on aircraft and later on ballistic missiles. This ambition, highly controversial in France, represents the only major area in which industry can be described as operating under confusion.

French parliamentary approval of the atomic strike force was voted only because a majority of deputies–which opposes the concept–didn't want to create political difficulties for the de Gaulle regime during the Algerian crisis. Once this political problem is resolved, as it may be this year, parliamentary agitation against an atomic strike force may create planning problems for industry.

France's nuclear strike force is part of the government's five-year military plan ending in January, 1965. In this period France expects to spend $6.2 billion on various military projects. Included is $1.1 billion to help finance the strike force.

This force breaks down into:

- **50 Dassault Mirage IV** twin-jet bombers to be operational by 1965–$200 million.
- **Research and development** of nuclear weapons, including $30 million to be spent on an isotope separation plant–$800 million.
- **Development and preproduction** of ground-to-ground strategic and tactical ballistic missiles–$150 million. Tactical missile development will take $20-$30 million of the total.

France's atomic strike force would come into being in two stages.

First would be reached by 1965 when the 50 Mirage IV bombers would be operational. The two-place delta-wing bomber is powered by two Snecma Atar 9 afterburning turbojets which develop 13,228 lb. thrust each. Bomber reportedly is capable of carrying its atomic load 1,500-2,200 mi. at speeds approaching Mach 2.2. It is understood the Mirage IV will carry a glider-type atomic bomb which will have a glide range of 220 mi., thus easing the bomber's range difficulties. In its present 50,000 lb. version, it is unlikely the Mirage IV could be equipped with air-surface missiles of the Skybolt type.

A single Mirage IV prototype has been flying since mid-1959 and three preproduction models are being built. Initial deliveries of the 50 production models to be ordered are scheduled to begin in 1963. Some of these aircraft probably will be delivered as aerial tankers, to use the buddy system of in-flight refueling.

Critics argue that a fleet of 50 aircraft wouldn't have a chance of piercing Soviet air defenses in 1965. Moreover, public testimony by government officials has revealed that France won't have an important stock of plutonium-type bombs before 1968. Thus critics question the value of having a Mirage bomber force ready by 1965.

These critics, many of whom nonetheless favor the controversial concept of an independent French nuclear deterrent, would like to see the government bypass the first stage and move directly to the second.

Second stage is expected to come into being between 1968-70. Then France would replace its aircraft strike force with tactical and strategic ballistic missiles equipped with nuclear warheads using enriched uranium produced by the isotope separation plant provided for under the five-year program. This plant is to be in operation by 1966.

Objective Maintained

Work on this stage is being carried out by a consortium of French airframe, engine and chemical companies. Set up in 1959, this group, called SEREB, reportedly has maintained its initial objective of developing a solid propellant IRBM missile with a 1,500-2,500 mi. range. Originally, SEREB's missile was to be ready by 1965. Observers close to the project think 1970 is a more likely operational date.

SEREB's mission has been complicated by a ban placed by Washington in the fall of 1959 against U. S. companies working with SEREB on a bilateral basis. Washington, considering a plan to encourage a NATO-wide IRBM project, wanted to discourage an independent French program.

Weapon Development

Since the ban, the French government, by exploding three nuclear devices, has made it fairly clear that it plans to maintain its program whether Washington lends a hand or not. French are hoping the new Administration reconsiders U. S. refusal to help SEREB.

New agreements between French and U. S. companies may be reducing the ban's effect. Thus SEPR, French rocket company owned by two aircraft and four chemical companies involved commercial agreements during the year in SEREB work, signed agreements with North American's Rocketdyne Di-

DASSAULT MIRAGE IIIC

An invitation to Engineers and Scientists

The serious minded scientist and engineer who is considering a career change is frequently at a disadvantage because he does not know precisely what positions are available to him. Nor, until now, has he usually been able to find out in a professional, dignified, confidential way.

To meet this professional need the Aerospace Engineering Division of Hughes Aircraft Company announces the inauguration of a new service for scientists and engineers which notifies you whenever an opening occurs which we believe may be of interest to you.

An *Engineering and Scientific Register* has been established wherein you may record your qualifications and interests, even though you are working and not actively seeking a different position. Whenever new opportunities arise, this register is systematically and thoroughly searched.

Hughes is constantly developing new frontiers in science that create needs for specialized knowledge and talent. When these needs arise, we first search the records of present employees; but new developments frequently create a demand for key additions to our scientific and engineering staffs.

Through Hughes' *Engineering and Scientific Register*, we know about you, what you can do and what you would like to do. When a challenging opportunity develops that fits your particular qualifications and desires, we can get in touch with you. You do not make application for employment and no contact is made with present or past employers. You merely permit us to advise you whenever an opening occurs which we believe may be of interest to you. At that time you can decide whether you wish to accept our invitation to be considered as a candidate for the position.

If you would like to be listed in our *Engineering and Scientific Register*, we cordially invite you to fill out and mail the request below.

HUGHES

HUGHES AIRCRAFT COMPANY

AEROSPACE ENGINEERING DIVISION

Administrator, Engineering & Scientific Register
Hughes Aircraft Company
Culver City 17, California

Please send the form (not an application form) on which to profile my professional background, experience and interests for inclusion in the Hughes' Engineering and Scientific Register.

Name_____

Address_____

City_____ State_____

Degree_____ Professional Field_____

SUD ALOUETTE III

vision and with Thiokol Chemical Corp., the latter dealing with solid rocket work.

During 1960 the French fired a four-stage research rocket designed to yield data on ballistic missile re-entry. First and third stages were made by SEPR, second stage by French Navy and final stage by ONERA, French equivalent of NASA. ONERA conducted firing and programing for Sud Aviation, which has major responsibility within SEREB in the French IRBM program.

Striking Force

Until this atomic strike force comes into play, bulk of French air force power will be centered on Dassault's dual-capacity interceptor-attack fighter, the Mirage IIIC. (Letter "C" designates the Mirage III production version.) Mirage IIIC deliveries to the air force began last fall and delivery rate is expected to hit nine per month this spring. Orders cover 200 aircraft and the government's five-year military program indicates this number may be doubled.

New orders are likely to include the Mirage IIIB, a two-seat trainer.

Mirage IIIC is powered by a single Snecma Atar turbojet developing, in an improved version, just over 14,000 lb. thrust with afterburning.

On interceptor missions the airplane is equipped also with a SEPR 841 rocket engine delivering an additional 3,300 lb. thrust. Air-to-air missile, slung on the belly center-line, is either Matra 511, or derived versions, or Nord's AA-20.

Builder claims that five ground crewmen can convert the interceptor to the attack version within 30 min. Aircraft's gross weight varies from 18,620 lb. for a high-altitude intercept mission to 22,150 lb. for a long-range—600 mi.—strike mission.

French air force considers the multi-purpose capability of the Mirage does away with the need for lightweight strike fighters like the Fiat G. 91 or several types developed by French companies. The Mirage force, it is believed, will be retained within the French air force rather than committed to NATO European air units. French NATO air commitments will continue to be met by French units flying F-84s, RF-84s and F-100s, turned over to France as U. S. military aid.

Transport Needs

Transport needs, now handled largely by Nord's twin-engine Noratlas aircraft, will be met when production gets under way on the Franco-German C-160 Transall project. A Nord design, the Transall is powered by two Rolls-Royce Tyne turboprops and will cruise at 275 kt. with an eight-ton payload.

Initial prototype is being built by Nord and will be tested in France. Two other prototypes will be built in West Germany. For the moment only these three prototypes have been financed. Initial C-160 flight is slated for the end of this year with production—to 400 aircraft—scheduled to begin in late 1962 or early 1963.

French air force is also seeking design bids on a light cargo aircraft to fit mission requirements throughout the French African community. Five-year military program has earmarked $36 million for this order for which the air force hopes—probably vainly—to get 80 aircraft. The air force wants a light STOL transport capable of flying 950 mi. at 220 mph. with a 3,000-lb. payload and expects to decide on an aircraft early this year.

Bidders on this requirement are Dassault, Breguet and Max Holste. Dassault is putting forth a modified version of its Communaute, civil counterpart of its Spirale developed for Algerian military needs, but unordered. Max Holste is offering a cargo version of its Super Broussard which already is being produced for the civil market. Breguet appears to come the closest to the air force STOL requirement with a modified version of its blown-wing 941.

This aircraft, designated the 945, would also use the blown-wing principle and would be powered by two Turbomeca Turmo IIID free turbine engines operating four propellers. Breguet says it could fly the airplane 21 months after go-ahead.

Algerian Needs

Air force missions, obviously, still are dominated by the need to meet air demands in Algeria. Hundreds of jet-trained air force pilots are tied down in Algeria accumulating considerable flight hours on North American T-6s and T-28s and Douglas AD-4 Skyraiders and A-26s. Solution of the Algerian problem—which has turned too many officers into politicians—would enable the air force to devote itself to more modern military concerns.

Missile capability, besides the now well-known Matra and Nord air-to-air weapons, continues to center on Nike versions given to air force units to meet NATO needs. French air force will also operate Hawk anti-aircraft missiles being built in western Europe by

five NATO European members. French share in the production scheme involves three battalions.

French Navy is well advanced in developing a light carrier force capable of launching strike attacks and ASW missions. This force will be based on the 22,000-ton sister carriers, Clemenceau and Foch. Clemenceau, already carrying out sea trials and handling aircraft, is to enter operational status late this year or early 1962, Foch in 1964.

Navy's strike power is based on Dassault's Etendard IVM fighter. Etendard is powered by a single Snecma Atar 8 developing 9,700 lb. thrust. Navy has ordered 100 Etendards with deliveries to begin next fall. A half dozen preproduction models now are flying in an accelerated test program. Initial carrier qualification tests were successfully completed last September aboard the Clemenceau.

Flying at just over Mach 1, Etendard has a strike range of 400 naut. mi. Normal gross weight is 18,000 lb. and maximum mission weight is just over 22,000 lb. Of the 100 on order, 15 will be fitted out for tactical-reconnaissance missions. This version, designated Etendard IVP, has camera equipment and a flight refueling probe installed in nose.

Navy's carrier-based ASW aircraft is Breguet's three-place Alize, already in service. Navy has ordered 87 of the single Rolls-Royce Dart turboprop aircraft and 60 had been delivered by 1960 year-end. Deliveries are being made by Breguet at the rate of four monthly.

These two aircraft—the Etendard IVM strike fighter and the Alize ASW aircraft—will form the bulk of the Clemenceau and Foch air units. Each carrier will have complement of 60 aircraft.

For its shore-based ASW missions, Navy plans to operate Breguet's 1150 Atlantic, powered by two Rolls-Royce Tyne turboprops. Early last year this Breguet design was chosen by the U. S. and four NATO nations under a joint financing scheme. First two prototypes are under construction and its initial flight is expected to take place late this year. Navy, for its share in the program, has provided money for an initial batch of 27 aircraft.

Atlantic is a midwing aircraft with a wingspan of 124 ft. and gross weight of 86,000 lb. Cruising speed is 375 mph. Atlantic will be capable of 10-12 hr. patrol missions.

Navy's missile interest appears to be centered on two weapons, both French designed. One is a glider-type for antisubmarine warfare, the Malafon. Second is a Mach 2 anti-aircraft weapon, the Masurca. Latter can deliver a 220-lb. warhead in a 20-mi. range. Launch weight is 3,200 lb. and service ceiling is 70,000 ft. Missile uses solid propellants. Neither missile is operational.

Sud Aviation, France's largest airframe company, continues to provide the industry with over one-third of its activity via subcontract work on the Caravelle jet transport. Sud is industry's biggest single exporter, not only with its Caravelle but also with its Alouette helicopter. Latter has been sold in 22 different countries, with orders nearing the 800 mark. Only 350 Alouette IIs, now being turned out at the monthly rate of 16, represent French military orders.

Sud, in fact, recently decided to launch production of its Alouette III, a 7-seat, larger version of the Mark II model, without waiting for French military to place an order. Initial orders for the Mark III already have been received from Burma and Sweden. This move is another example of industry's increased independence from French military budgets.

Sud's other main helicopter activity continues to center on its triple-turbine Frelon helicopter, still undergoing tests. Civil version of the Frelon, of which two prototypes are flying, can carry 28 passengers. Thirty hours have been logged on the prototypes and a maximum speed of 131 kt. has been reached. Cruising speed has been estimated at 124 kt. French navy is interested in the Frelon for ASW work. Power plants are three Turbomeca Turmo engines rated at 785 ehp.

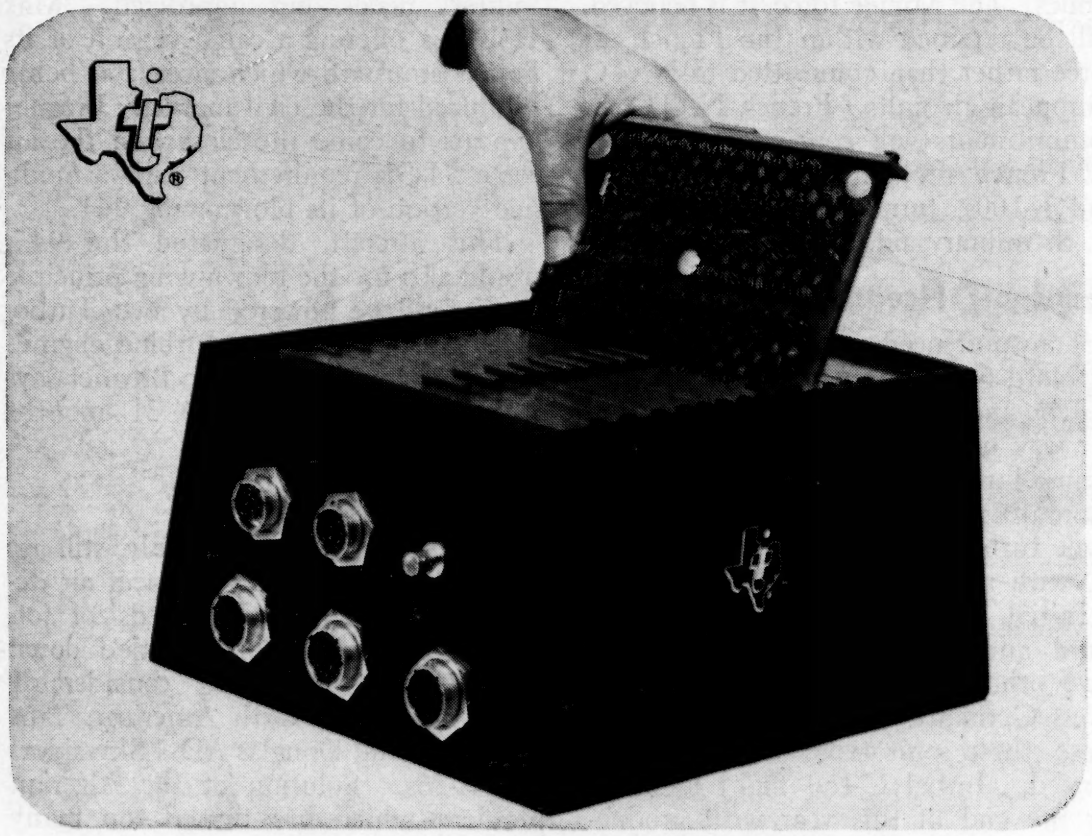
Sud's helicopter division is assembling 252 Sikorsky S-58s at the rate of four per month. By 1960 year-end, 208 had been turned over to French air force and navy, mainly for missions in Algeria.

Sud's biggest activity, of course, is Caravelle production. Georges Hereil, Sud's energetic president, is hopefully predicting that 1961 "will be the American year" for his Caravelle.

Last year, Sud marked its first U. S. airline sale—20 Caravelles to United Air Lines, plus another 20 on option. Caravelle No. 62, the first United Caravelle, flew early this year. Hereil expects a break in the U. S. market once United begins its Caravelle operation this summer. By next January, United will be operating all of its 20 Caravelles in the U. S.

U. S. Caravelle sales are being handled by Douglas under the latter's agreement with Sud. Sud and Douglas have abandoned a modified version of the Caravelle—designated Caravelle XIV—for the U. S. market.

This version, aimed at more direct competition with Boeing's three-engine 727, would have used a Douglas-designed wing permitting a cruising speed of Mach .84. Aircraft was to have been



High/low-level PCM telemetry system . . . with ±0.25% accuracy, nulled-out drift.

TI PCM TELEMETRY IN MISSILE SYSTEMS

APPARATUS DIVISION

TEXAS INSTRUMENTS INCORPORATED
6000 LEMMON AVENUE • DALLAS 9, TEXAS

Circle Number 284 on Reader-Service Card

powered by two Rolls-Royce RB 141-11A turbojets and would have hauled 95 passengers instead of 85. Maximum weight would have jumped to 104,000 lb. from the present 90,000.

Hereil says Caravelle XIV project was dropped simply because there was little airline interest in the aircraft. He considers this lack of interest as evidence that the Caravelle, as it currently exists, is more interesting to an airline than any version designed to make it compete more directly with the Boeing 727.

Caravelle and 727

Hereil himself considers that his Caravelle is a complement to the 727, not a competitor. To him it makes sense that United's fleet contains both the Caravelle and the 727. Latter's gross weight of 142,000 lb. makes it a different aircraft than the Caravelle, which grosses 90,000 lb.

Though Sud and Douglas have abandoned the Caravelle XIV, they nevertheless are offering the Caravelle in the U. S. with powerplants other than Rolls-Royce turbojets. Caravelle VII is fitted with two General Electric CJ805-23 aft-fan engines. G. E. purchased a Caravelle to carry out its own flight test program and initial flight of Caravelle VII took place late in December. Sud-Douglas also are planning to offer two Pratt & Whitney JT8D turbofans under a designation of Caravelle X.

Caravelle orders are now reaching the 120 mark, with Sud's breakeven point roughly 220 aircraft. Hereil considers this an easy objective to hit.

Looking to future Caravelle developments, Sud signed an important agreement with Dassault under which both companies agreed to develop jointly a supersonic medium-range airliner, the Super-Caravelle Sud Dassault. The companies say the transport would fly in the Mach. 2.2 region, have a range of 2,500 mi. First prototype could be flying by 1964, according to Hereil.

There is some doubt that this project will ever get off the ground. For one thing, it assumes considerable government support. Before agreeing to back the project, the government has asked a private transport organization, Air Transport Institute (ITA), to study feasibility of a medium-range supersonic transport.

A second part of the Sud-Dassault agreement concerns joint backing of Dassault's twin-turboprop Communaute, which has attracted considerable international interest. One prototype exists, powered by two Turbomeca Bastan turboprops of 1,000 shp. each. Maximum cruising speed is 335 mph. Gross weight is 15,500 lb.

Production of the Communaute very likely will depend on international rather than French orders, despite the fact that the Communaute originally was developed for service in the French overseas community.

French industry has four major light civil transport projects in the works in addition to the Communaute. These are:

• **Max Holste's** twin-turboprop MH 260 Super Broussard. The 20-23 passenger DC-3 replacement is powered by two Bastans. Two prototypes are in the testing stage and French government has agreed to finance a third—the MH 262—which will have a circular, pressurized fuselage.

Holste, under an agreement with Nord Aviation, has moved into the production planning stage on the Super-Broussard. First production model will fly at the end of this year. Seventeen aircraft will be produced in 1962 and a monthly production rate of four will be reached early in 1963. Nord will handle about 80% of the production.

Holste has letters of intent from various airlines for 80 aircraft. Possible U. S. interest in the feederliner will be handled by Cessna Aircraft, which took a 49% interest in Holste stock last year.

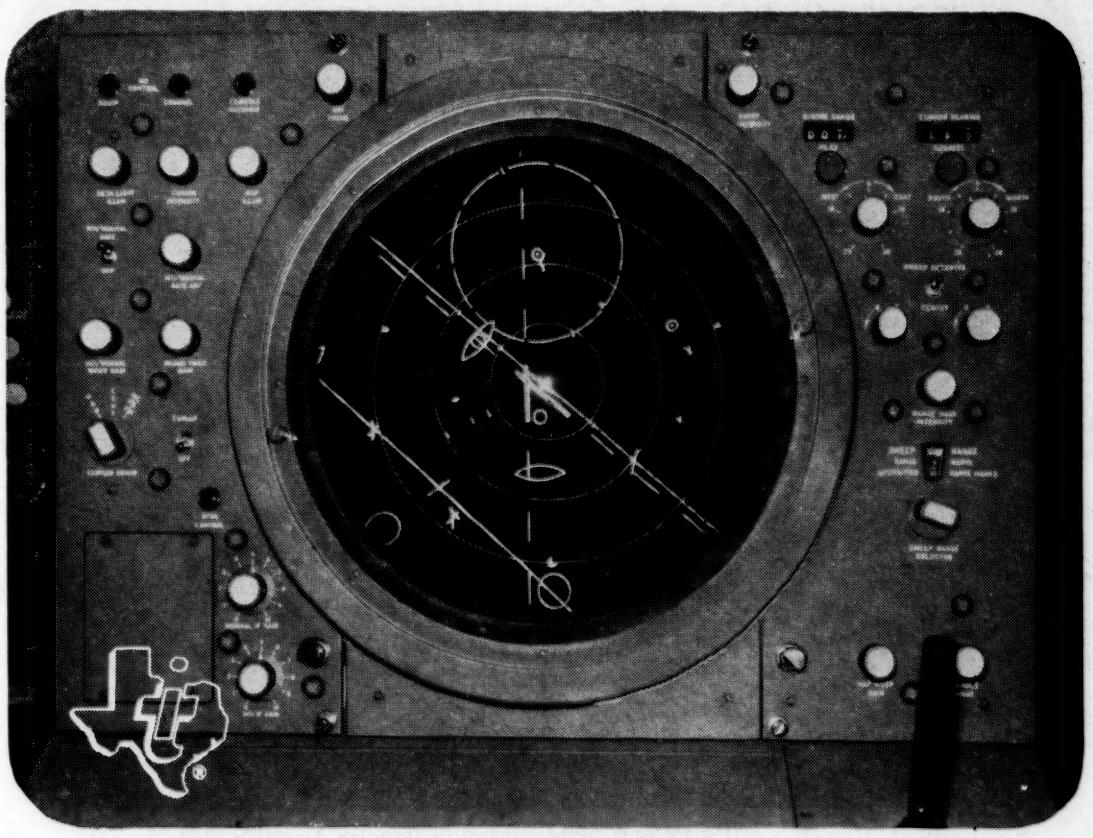
• **Breguet 941** STOL transport. Prototype, to fly in May, is powered by four Turbomeca Turmo IIID turboprops delivering 1,170 shp. on takeoff and 1,040 shp. maximum continuous. Aircraft uses vectored slipstream principle to operate out of airstrips 600-1,200 ft. long. Gross weight is 20 tons and payload 6 tons. Pressurized version, Type 942, carries 50 passengers.

• **Potez-Air-Fouga P.840** feederliner, a private venture. Aircraft is powered by four Turbomeca Astazou turboprops, will carry a 5,300-lb. payload 625 mi. at 300 mph. cruise speed. Initial flight is scheduled for early this year. FAA certification was requested in September. Second prototype is now being built to accelerate testing program.

• **SIPA 272 Presence.** Another private venture, the 272 is a small, twin-boom cargo plane with gross weight of 9,000 lb. Powered by two Turbomeca Astazou 500-hp. turboprops, Presence will haul 16 economy-class passengers. Project and design work have been completed and a mockup now is being built.

An interesting aspect of these five projects is the use of Turbomeca turboprops, either the 1,000-hp. Bastan or the 500-hp. Astazou. Turbomeca, a private engine company, is doing a brisk business with its varied line of helicopter and fixed-wing powerplants.

Snecma, a big state-owned engine company, also is in better condition as a result of Mirage III orders at home and abroad.



Ground clutter is eliminated by TI moving target indicator shown with video map at 20-mile range.

TI IN HEAVY RADAR SYSTEMS

APPARATUS DIVISION

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE • DALLAS 9, TEXAS

Circle Number 285 on Reader-Service Card

● ITALY

Italy Benefits In F-104, G. 91 License Production Programs

Geneva—Major segments of Italy's aviation industry, with license agreements pumping in new funds and advanced techniques, are heading toward a bumper year in 1961.

Of the two major license agreements now in force, one is outgoing, the other incoming, and both revolve around Italy's largest aircraft manufacturer—Fiat.

Latest boon for Fiat stems from an Italian government decision to join West Germany, The Netherlands and Belgium in the European common production program for the Lockheed F-104G all-weather interceptor.

U. S. Funding

By ordering 75 of the aircraft, Italy received assurances of U. S. mutual aid funds equivalent to another 50 F-104Gs for a total of 125 to replace large increments of the air force's present inventory of approximately 300 North American F-86 series interceptors and Republic F-84 fighter-bombers.

Fiat, in return, became a full partner in the European industry consortium, eligible for its share of the West German order whose size outstrips the capabilities of that country's internal production capacity.

Under present programing, Fiat will build a total of 182 F-104G airframes—including 57 for West Germany—with production through 1964 at least. The company also will be responsible for approximately 19% of the European licensed production of the 15,000-lb.-thrust General Electric J79 turbojet that will power the F-104.

Italian subcontractors will profit down the line, with Alfa Romeo expected to be assigned a large piece of the J79 component production program.

The outgoing agreement that represents a breakthrough into wider market areas for major homegrown products gives West Germany the right to produce under royalty license a total of 280 Fiat G. 91 lightweight strike fighters within its own factories. Germany is purchasing 50 G. 91 fighters and 20 trainer versions directly from Italy, and Fiat will supply Greece and Turkey with a total of 50 of the aircraft to be financed by mutual aid funds from the United States.

Fiat also has granted the U. S. government production rights for the G. 91 and hopes that orders may be forthcoming from either the Air Force or Army—or both. The Army is currently evaluating two of the aircraft at Ft. Rucker, Ala., and the Air Force is expected to follow suit at Kirtland AFB, N. M., with another two G. 91s imported from Italy.

With or without U. S. orders, G. 91 production figures should top the 600 mark, a figure not so high as Fiat had once hoped nor nearly so low as it had once feared.

As in the case of its other partners in the F-104 program, Italy and its industry are becoming more and more bound to the common production concept. Partially this is because the types of major weapon systems feasible for Western Europe are narrowing as costs leapfrog and complete financial support by any one nation becomes prohibitive and partially because the needed techniques, skills and facilities outstrip those available to a single country.

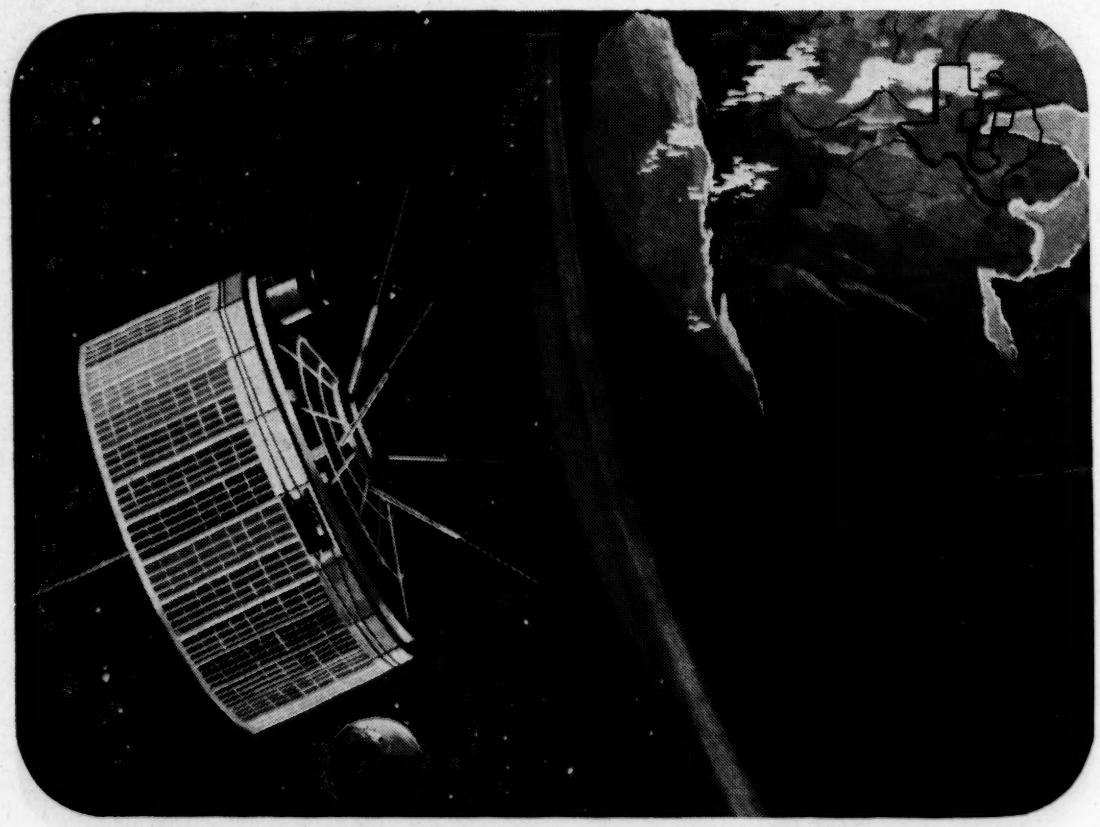
Italy, for instance, may or may not place an entry in the North Atlantic Treaty Organization's forthcoming competition for a VTOL close-support fighter. Win, lose or no entry at all, it still is practically assured of its share of production of such a vehicle if sufficient orders from North Atlantic Treaty Organization members follow the final decision.

It also is closely allied with Germany and France in helicopter research and development programs, and the fallout from these projects should assure additional production. For the moment, license agreements provide the life ring, the U. S., the technology.

While the F-104 and G. 91 represent the most significant breakthroughs in this field, the Italian industry as a whole has relied largely upon licensed production to help it back along the post-World War II pull. Giovanni Agusta, for example, rebuilt itself with the production of Bell helicopters beginning in 1952, Fiat with the manufacture and assembly of F-86Ks whose design is reflected in the smaller G. 91 tactical fighter.

Agusta is now producing the Bell 47J and 47G in quantity for the European market and is bringing out a new design utilizing the Bell HU-1A rotating components and the Canadian Pratt & Whitney R1340 engine developing a maximum of 600 hp. Designated the Agusta 102, six of these nine-passenger helicopters already have been sold within Italy and another five within Spain.

In another step, using experience



TI electronic flight control in Douglas Aircraft's Delta launch vehicle helped orbit the NASA weather satellite TIROS II.

TI FLIGHT CONTROLS IN SPACE EXPLORATION

APPARATUS DIVISION

TEXAS INSTRUMENTS INCORPORATED

6000 LEMMON AVENUE • DALLAS 9, TEXAS

gained through Bell production, Agusta is developing a 40-50 passenger turbine helicopter powered by 1,000-lb.-thrust de Havilland Gnome powerplants and designated the 204B. Fifteen of these have been ordered by the Italian government, and Agusta is looking for further orders both within and outside Italy. It had hoped to crack West Germany, which is now reviewing its large helicopter requirements and is the most affluent of all potential European customers, but in this case sources in Bonn say the chances for the 204B are small.

Another Italian firm, Aeronautica Macchi, is rolling out its prototype of the Lockheed LASA 60 single-engine utility aircraft which it hopes to market throughout Europe. Partially owned by Lockheed, Macchi hopes to produce 75 of the aircraft this year, then jump to an annual rate of 100-150 if the market warrants. The aircraft will be sold in Europe under the designation Lockheed Santa Maria, and Macchi says a number of air taxi and oil operators from several countries are interested.

A further example of U.S. aid in the form of license agreements is Microtecnica's adaptation of the Norden stabilized platform as a navigation and fire-control unit for cruisers under a $50,000 Italian navy development contract. If the system meets navy expectations, production orders are expected.

Piaggio seems likely to enter the race toward development and production of a relatively low-cost executive turbine powered transport with technical aid from Douglas Aircraft Co. as a follow-on to the Italian firm's series of Gull amphibian and land-based aircraft. Plane would be twin-engined, probably incorporating the Pratt & Whitney PT6. Financial backing for the project would be largely supplied by the Italian government and Piaggio.

Original promising designs outside the business flying field include Fiat's 7002 cold jet helicopter and Macchi's M. B. 326 two-seat jet trainer.

The 7002, powered by the Fiat 4700 gas generator which provides about 530 hp. at takeoff, made its first flight earlier this year, remaining in the air for approximately 30 min. Grossing 3,080 lb., it has useful load of 1,760 lb.

Macchi thus far has produced 30 M. B. 326 trainers, most of them going to the Italian air force which is using the aircraft at two different training centers. The 1,750-lb.-thrust Bristol Siddeley Viper ASV 8 turbojet powerplant used on earlier models is now being replaced by the 2,460-lb.-thrust BS V. 11. Macchi says several foreign countries have shown interest in the 450-mph. aircraft, including Lebanon, Portugal and Sweden, but no firm outside sales have yet been completed.

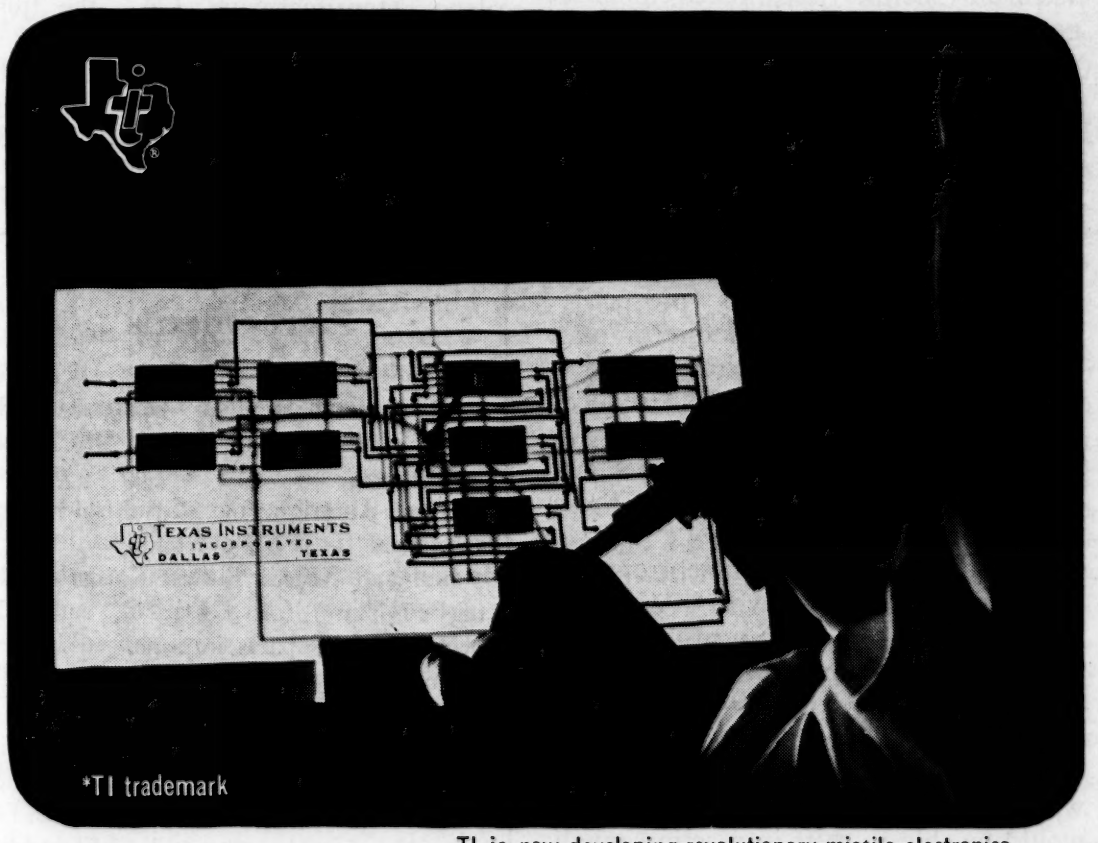
In space, Italy, like most of Europe, is taking its first tentative steps, its greatest accomplishments to date largely confined to the fields of bioscience and avionics.

FIAT 7002 HELICOPTER

In January, a two-stage Nike-Cajun upper atmosphere research rocket was launched from Sardenia with the aid of the U. S. National Aeronautics and Space Administration. The payload was designed by Italy's National Research Council (Consiglio Nazionale Delle Richerche), and the government is considering the establishment of a permanent launch facility on Sardenia. The Research Council and the Italian Air Ministry have each set aside approximately $485,000 for the continuation of the rocket sounding program.

Italy also is considering whether to join one or both proposed European common space projects now struggling to get off the ground. One program, whose framework was established at a Geneva meeting late last year, would have the development of satellite instrumentation packages as its primary goal. The other, largely backed by Great Britain and France who have hardware to sell, would provide the necessary launch vehicles.

Before becoming firmly wedded to either, Italy is expected to give serious study to NASA cooperative ventures that would put it into space faster and at less cost.



TI is now developing revolutionary missile electronics using SOLID CIRCUIT semiconductor networks.

SOLID CIRCUIT* NETWORKS
IN TI MISSILE SYSTEMS

APPARATUS DIVISION

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE • DALLAS 9, TEXAS

Circle Number 287 on Reader-Service Card

Delays in Starting F-104 Program Hamper Japanese Aviation Growth

Tokyo—Japan's aircraft industry—with vast potential in a country which now takes its place as the fifth largest industrial complex in the world—still lies largely dormant. In a welter of complications involving the intricacies of Japanese politics the future is cloudy.

Here are the elements:

• **Program to equip** Japan's Self-Defense Air Force with 200 F-104Js is moving, but temporarily bogged down in the problems of tooling and modifications.

• **YS-11 project**—production of a Japanese-designed and built medium-range turboprop transport—is moving slower than had been anticipated because of the reluctance of the government to grant subsidies.

• **Helicopter production** on U. S. licenses has slowed due to the Diet's reluctance to go along with a Self-Defense Naval Force project for a helicopter carrier.

• **Japanese designers'** belief that they could do well in the vertical takeoff field, applying some of the design skill which is paying off in other theoretical scientific fields, has received little government attention.

If there is a bright note in the industry picture, it comes from the nature of the Japanese aeronautical industry itself. Most of the aircraft makers are actually divisions of or related companies to the big Japanese metalworking companies which have been enjoying enormous prosperity. Thus, Japanese manufacturers have maintained their staffs, their facilities, and have financial resources. Employes in Japan normally enter a company for lifetime employment. And the employer has a responsibility to keep them on in fair weather or foul.

Japanese aircraft manufacturers are continuing to join with American manufacturers in technical licensing agreements. Many of the Japanese manufacturers have patterned their own operations on those of the U. S. companies. That means that if and when the turn comes, the industry would be able to shift into action much faster than many foreign observers now believe.

The F-104 project finally gets off the ground this spring. The Self-Defense Force will sign a contract with Mitsubishi Heavy Industries and Mitsubishi is expected to go ahead immediately with its subcontracts, which will include pieces of the whole project under sublicense and subcontract for virtually the entire industry. Mitsubishi Heavy Industries already has received a letter of intent. In addition, through Mitsubishi 40 engines for the fighters will be ordered directly from America—20 for the F-104D two-seat trainer, and 20 for the first production models of the new fighter.

The first 20 will be assembled in Japan of U. S.-made parts through grant from the U. S. Air Force through the Military Assistance Advisory Group in Japan. The 21st and the remainder of the 200 will be the modified J type and will be of all-Japanese manufacture. Current schedules call for the first all-Japanese-made fighter to be produced in January, 1963. Local manufacture of engines and fuselage will begin in January, 1962.

A spokesman of the Society of Japanese Aircraft Manufacturers says that the first YS-11—the first postwar Japanese designed plane—will be flight tested by the end of this year. Jigs and some machine tools are already being produced. The airframe will be ready for testing in a few months—perhaps in late autumn.

But some big questions about the aircraft are still pending. Nippon Aeroplane Manufacturing Co., the joint enterprise set up by the industry to build the plane, needs more money for the project. It has estimated the figure at about $55.5 million. The industry has asked the government to put up 60% and the remaining funds would come from Nippon Aeroplane's stockholders. But the Japanese Finance Ministry—iron-handed keeper of the government's books—has already thrown the project back and demanded that the shareholders round up 50%. Even then it is far from clear whether the project will get through the rough-and-tumble of this spring's Diet discussions of the total government budget.

Meanwhile, Nippon Aeroplane is getting only lukewarm encouragement from Japan's two airlines—Japan Air Lines and All Nippon Airways. Both have taken a wait-and-see attitude before they place any orders for the aircraft. All Nippon's recent purchase of Fokker F-27 Friendships and additional Vickers Viscounts is taken as an indicator that it is not particularly interested.

The helicopter boom—which some optimist's in the industry had predicted—has failed to materialize yet. The Self-Defense Forces have placed orders for three Sikorsky S-61s with Mitsubishi Heavy Industries and will place an additional order for two or three Vertol 107s with Kawasaki Aircraft. Fuji Precision Industries has applied to the Ministry of International Trade & Industry (MITI) for approval of a licensing arrangement for Bell's HU-1B and expects approval with an order for a small number of helicopters from the Self-Defense Forces. The Self-Defense Forces are also expected to place an order for 10 trainers of the Fuji KM2 type some time during the year.

The Liberal-Democratic Party, the ruling party of Prime Minister Hayato Ikeda, in a position paper released last fall on the aviation industry, has drawn up a list of priorities for the industry in aircraft manufacturing. It proposes that the YS-11 project be given support as well as research on Japanese designs for a vertical takeoff and landing plane, a high speed transport, and a cargo plane. But there were no concrete suggestions on how these projects were to be implemented.

In design and research circles, the VTOL project has widespread support.

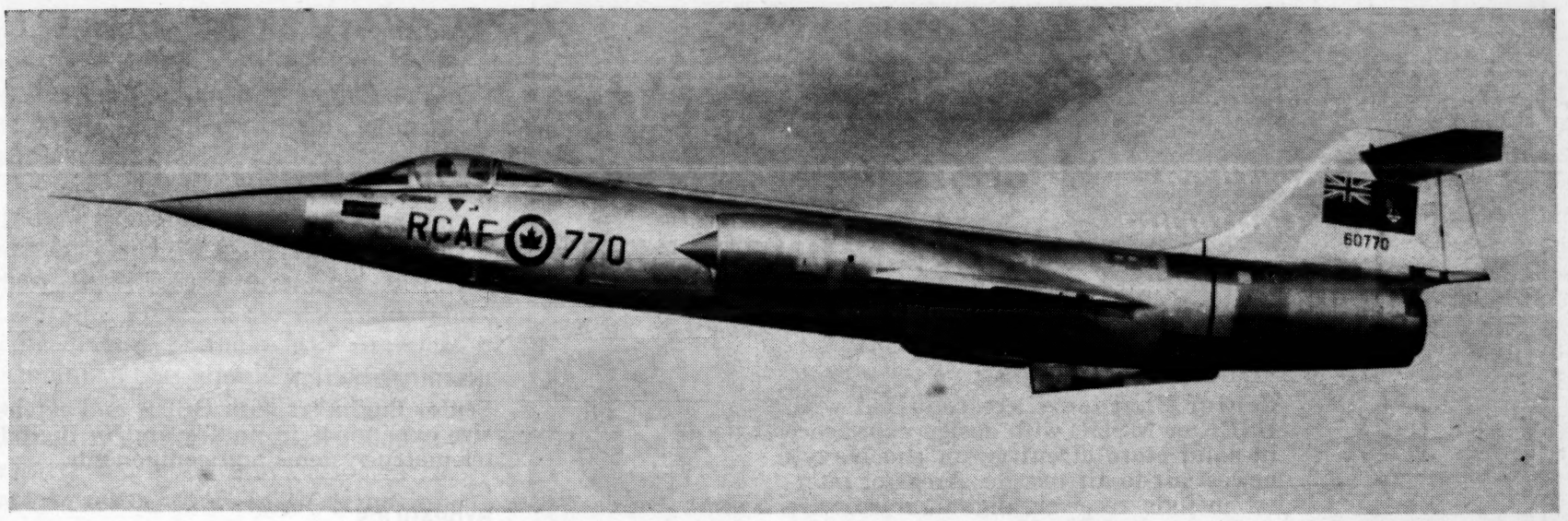
A VTOL group has been established in the Aircraft Industry Discussion Council, formed to act as an advisory body to the Ministry of International Trade & Industry on aircraft. But so far its activities have been largely limited to collecting data on what is being done in this field in other countries.

Some industry spokesmen are calling for the setting up of a joint industry and government company like the Nippon Aeroplane Manufacturing Co. which will produce the YS-11 transport to work on plans for a VTOL. But nothing concrete has materialized.

U. S.—Japanese Agreements

Japanese production of the Lockheed F-104 bulked large in Japanese-U. S. trade agreements signed in 1960. These included:

- **North American and Mitsubishi Heavy Industries for F-86 overhaul.**
- **Bell and Mitsui Bussan Kaisha (trading company) for 47D1, G, and G2 helicopter and parts imports.**
- **Hex-cel Products and Showa Aircraft for honeycomb construction.**
- **Hamilton Standard and Sumitomo Precision Industries for propellers and parts.**
- **Lockheed Aircraft and Mitsubishi Heavy Industries for F-104J.**
- **Pratt & Whitney Aircraft, and Mitsubishi Heavy Industries for engines and parts.**
- **General Electric and Ishikawajima Heavy Industries for J79 engine production and repair.**
- **Hughes Aircraft Co. and Japan Aviotronics for fire controls.**



FIRST U.S.-BUILT LOCKHEED CF-104

Recession Spurs Canadian Defense Debate

By Herbert J. Coleman

Ottawa—Canadian aircraft industry, increasingly troubled by political wrangling over the nation's defense policies—or lack of them—is doing its best to ride out the storm until a pattern emerges.

Defense, accounting for one-third of the Canadian budget, is getting a closer scrutiny than ever before, in the face of rising unemployment and a surge to protect Canadian sovereignty.

On the parliamentary level, a small but vocal group advocates reducing emphasis on the Royal Canadian Air Force's mission of interception. Others seek complete disarmament as a signal example to world powers.

Canadian sovereignty is a political spark constantly fanned in parliamentary debates. There are tinges of anti-American sentiment, largely due to U.S. control of some Canadian companies, and widespread use of U.S. weapons after cancellation of Canadian-developed types, such as the Avro CF-105 Arrow.

Opposing Views

At the moment, defense policies are debated by two camps. One would have the RCAF fly first-line fighter interceptors as part of its commitment to North American Air Defense Command (Norad). The other would keep the RCAF mission in the realm of transport and air defense aircraft identification.

The mood within the RCAF, justly proud of its traditions, is best described as bitter. Interceptions and identifications now are made with the aging Avro CF-100. As one top-ranking officer put it:

"The CF-100 was good in its day. But now the airplane is even a handicap in Norad exercises, because it gets in the way of the USAF's F-106s. And worst of all, the CF-100 can't even catch Trans-Canada's DC-8s."

Not long ago, the RCAF had high hopes for a trade of 40 Canadair CL-44 turboprop transports to USAF's Military Air Transport Service, in return for 70 McDonnell F-101B Voodoo interceptors taken from the U.S. inventory.

But in the subsequent parliamentary wrangle over the RCAF's mission, the deal bogged down and USAF has since ordered Boeing KC-135 jets and Lockheed C-130 Hercules turboprops.

It was this factor that determined the future course at Canadair, builder of the CL-44 at Montreal. That company, now working on planes ordered by U.S. cargo lines, has spurred its sales and cargo research campaigns in a drive toward survival in the commercial market.

Another Canadair plane, the CL-41 jet primary trainer, also is caught in the political crossfire. In top government levels, the thinking is that if the RCAF will not have an interceptor role there is little need for a jet trainer.

Jet Trainer Needed

Conversely, the RCAF believes that the jet trainer is necessary to its mission. Pilots must be trained for the Lockheed F-104G which will replace CF-100s in the North Atlantic Treaty Organization Canadian wings. Currently, RCAF cadets train in North American T-6s and the jet-powered Lockheed T-33.

However, there is reason to believe that a CL-41 order will be made soon. The airplane is Canadair's only original design and two prototypes have been built with company money. One top government source told AVIATION WEEK:

"An order for the CL-41 is more probable right now than it has ever been before."

In the helicopter field, an order is imminent for 24 light helicopters, with the Hiller 12E the leading contender; Bell and Cessna also have submitted proposals: Kaman Aircraft hopes to sell 12 HU2Ks for anti-submarine warfare use. Two Vertol 107s are being considered for transport duties. Competition has been under way for two years.

Canada's defense budget totals $1.6 billion, and most of it is for the RCAF. Canada is working on a relatively small sounding rocket and satellite program through its Defense Research Bureau. There are no plans for missile development.

Nuclear Capabilities

Still another area of controversy, also a hot political subject, is the question of whether Canada will receive nuclear weapons. One faction in parliament contends it is wasteful to spend millions on the F-104G jet if Canada's NATO forces are not armed with nuclear warheads.

This factor enters into the U.S.-Canadian agreement to build two Boeing Bomarc ground-air interceptor missile bases in Canada. The warhead which will be used in Bomarcs has never been officially established.

Canada's Liberal Party is on record as feeling that the U.S. should keep its nuclear deterrent paramount, and the RCAF should become an identification force for Norad, since "an interceptor role is futile."

But Canada's defense minister, Douglas S. Harkness, sees the nation's role as one of security, part of the over-all North American deterrent.

"It is nonsense to think that Canada would remain neutral and untouched by

in Southern California

BENDIX-PACIFIC

offers these excellent opportunities

FOR ENGINEERS

"EAGLE" MISSILE PROGRAM

Senior Engineers are required with BSEE or MSEE with design experience in solid state circuitry on the Navy's newest air-to-air missile. Areas of interest include receiver, digital, microwave and servo systems; IF amplifiers, VCOs, discriminators, radar, missile control design, DC power supplies and digital-to-analog circuitry.

SYSTEMS RESEARCH

Engineers with BSEE or MSEE with background in circuit analysis or mathematical analysis.

AIRBORNE RADAR

Senior Engineers with BSEE or MSEE and experience in all phases of microwave and radar transistor circuit design.

MILITARY NAVIGATION

Senior Engineers with BSEE and experience in low frequency electronic circuit design, aircraft instrumentation, MIL specs or transistor techniques.

INSTRUMENTATION

Senior Engineers with BSEE and extensive experience in analog and/or digital telemetry systems and components.

HYDRAULICS

Senior Engineers with ME or BSEE and experience in hydraulic and pneumatic components or systems, and/or electronic experience as it applies to hydraulics.

UNDERWATER ORDNANCE

Senior Engineers with BSEE, MSEE and experience in the design of solid state circuitry, electro-acoustic transducers for ASW applications.

RELIABILITY

Senior Engineers with BSEE and component and application engineering experience.

Please send resume to

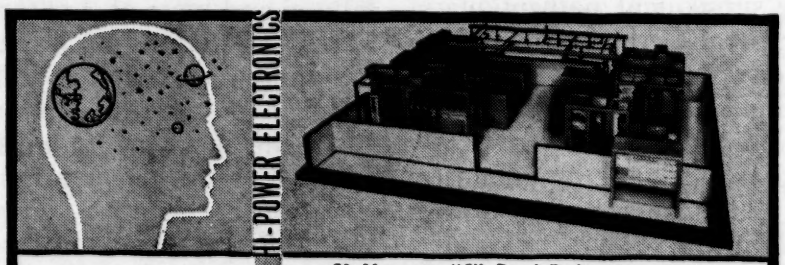
W. C. WALKER, Engineering Employment Manager

Bendix-Pacific Division

11600 SHERMAN WAY

NORTH HOLLYWOOD, CALIF.

THE Bendix CORPORATION



50 Megawatt "S" Band Radar Transmitter

The result of complex challenges

FXR's advanced techniques and facilities have produced the 50 Megawatt "S" Band Radar Transmitter for Cornell Aeronautical Laboratories. This transmitter, more than twice as powerful as the formerly largest unit of its class, will be used in the electronic exploration of the atmosphere and the ionosphere.

FXR has an extensive achievement record in solving demanding problems. Put this creative ability to work to help solve your High Power Electronics problem.

For detailed information concerning your particular application, contact your FXR applications engineer. He is only a phone call away.

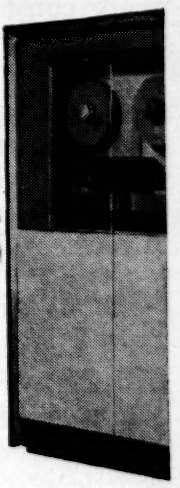
FXR, Inc.

Design • Development • Manufacture

25-26 50th STREET • RA. 1-9000

WOODSIDE 77, N. Y. • TWX: NY 43745

Circle Number 290 on Reader-Service Card



WORKING PARTNERS

RCA 501 AND SOUNDCRAFT INSTRUMENTATION TAPES

For many corporations, the heart of their data handling operation will be the new RCA 501 Computer System. Soundcraft Tape proved to be the perfect working partner for the "501" — not only in the crucial testing of the computer, but afterward, in continuous working use.

Experience has proven that Soundcraft works best on leading computer systems, like the RCA 501. Why not let Soundcraft Instrumentation Tapes go to work for you. Complete literature on request.

REEVES SOUNDCRAFT CORP.

Great Pasture Rd., Danbury, Conn. • Chicago: 28 E. Jackson Blvd.

Los Angeles: 342 N. LaBrea • Toronto: 700 Weston Rd.

R-116

Circle Number 308 on Reader-Service Card

a future war," he said. "Geographically, she is located between the Soviet Union and the United States. Whether an ally or neutral, she would certainly be in the nuclear firing line."

In reply to demands that Canada withdraw from an active air defense role, Harkness asked: "Do these people really believe that Canada would be entitled to a strong voice in the determination of the defense of the North American continent if we should withdraw our contribution to its air defense?"

On the question of Canadian sovereignty, Pierre Sevigny, associate defense minister, stressed that the joint command structure of Norad is not only "functionally sound, but it also safeguards the sovereignty of both Canada and the U.S. without prejudicing operational effectiveness."

This comment apparently was made to stem criticism of U.S. fighter interceptor force use of various Canadian bases as staging areas, for fueling and minor service.

Sevigny also terms the manned bomber a secondary threat alongside the intercontinental ballistic missile for which there is yet no defense, and thus he argues an air defense role against the bombers is mandatory for Canada's future safety.

This philosophy is continued into the use of the Bomarc. Present program calls for two sites, one near North Bay, Ont., and the other near La Macaza, Que. Both will be tied into the SAGE system and the Canadian Pine Tree radar network.

Fully manned, the two squadrons will number about 200 men. Eight RCAF men now are taking Bomarc courses in the U.S., and another five are assigned to the sites. They will become the nucleus of a training unit.

There has been some slippage in the construction program, but it now appears that the Bomarcs will be in operation late this year or early in 1962.

Because of the constant argument over the interceptor role, there is a feeling in top echelons of the RCAF that basically the air force is heading toward stronger emphasis on a transport role. In this mission, the prime mover is the Canadair CC-106, the CL-44 without the swing tail, backed up by the Canadair CC-109 Cosmopolitan, a Convair Eland turboprop conversion, and four Lockheed C-130B Hercules turboprops. Latter aircraft are primarily for use in re-supplying Arctic stations. New RCAF aircraft include.

• **Canadair CC-106.** RCAF has 12 on order and deliveries have started from the Montreal plant. Two will be used for operational training, eight for assignment to 426 Squadron at Trenton, and two others will be for VIP transport. The airplane replaces the Canadair

AVIQUIPO AROUND THE WORLD

Establish Your Overseas Market Through

AVIQUIPO, INC.

to Sell Your Products

Amsterdam
Bangkok
Brussels
Buenos Aires
Calcutta
Caracas
Frankfurt
Lisbon
London
Los Angeles
Lourenco Marques
Luanda
Milan
Montreal
Paris
Rio de Janeiro
Santiago
Sydney
Tokyo
Washington

27 YEARS EXPERIENCE in international trade have contributed to long-standing relationships with the worldwide aircraft industry.

20 SUBSIDIARIES are staffed with technical and marketing specialists extending on-the-spot service.

Export License No. 1

For more information concerning Aviquipo's global selling services, write to:

AVIQUIPO, INC.
90 Broad Street
New York 4, N. Y.

Cable Address: AVIQUIPO, NEW YORK
TWX: NY 1-2684

Circle Number 290 on Reader-Service Card

Calling the
SERVICE STEEL WAREHOUSE!
. . . THERE'S ONE NEAR YOU

BUFFALO CHICAGO CINCINNATI DETROIT LOS ANGELES

AIRCRAFT TUBING
CARBON ALLOY STAINLESS

SERVING THE AIRCRAFT INDUSTRY FOR OVER 40 YEARS

SERVICE STEEL Div.
VAN PELT CORPORATION · Mill: ADRIAN, MICH.

Circle Number 291 on Reader-Service Card

Circle Number 292 on Reader-Service Card

● CANADA

North Star, some of which will remain in service for navigation training and search and rescue.

• **De Havilland Caribou.** RCAF now has four in service; three have been placed on United Nations duty at El Arish, Egypt, and the fourth is used for training at Trenton.

• **Canadair CC-109.** Fitted with Napier Eland turboprops, this Convair 440 conversion is used for medium-range transport. RCAF has 10 planes, the complete order, now in service to replace Douglas C-47 transports.

• **De Havilland Otter.** RCAF received the last of its order of 28 airplanes last December and they have been assigned to 11 auxiliary squadrons for workhorse purposes.

• **Grumman Albatross.** Ten planes have been delivered and have been assigned to search and rescue work at three locations.

• **Lockheed F-104G Starfighter.** RCAF has ordered 200, plus 14 F-104D two-seater trainers, to be built by Canadair under license. Powerplant is the General Electric J79-GE-7 turbojet, built under license by Orenda Engines, Ltd. They will replace eight squadrons of Canadair Sabres now used in the Canadian NATO forces, plus four squadrons of CF-100s.

• **Canadair Argus** antisubmarine aircraft. RCAF now has 33 CL-28s in service with Maritime Air Command. Delivery was completed last September.

In the field of space, Canada has several projects under way, the most promising of which is its topside sounder satellite to measure the upper ionosphere. Four satellites are under construction. De Havilland is building the shells and Defense Research Bureau, which has overall responsibility, is making the instrumentation.

The satellite will be fired in the first quarter of 1962 from Vandenberg AFB.

Basically, the satellite will telemeter information about the structure of the upper levels of the ionosphere by using a radio sounder above the ionized layers, and will provide information about galactic noise and radio signals from space. The information will be used to explore long-range communications and undoubtedly will be considered as a means to determine defense against intercontinental ballistic missiles.

Satellite is made of aluminum and glass fiber, girdled by banks of solar cells. Weight will be about 275 lb. and diameter is 42 in. Orbit will be about 700 mi. Canadian Defense Research Telecommunications Establishment will operate four receiving stations in Canada.

The satellite will be of value in exploring unknowns of the aurora borealis, the phenomenon which has long plagued Canadian communications. Defense Research Bureau has developed the Black Brant II sounding rocket in another project to study this area.

Black Brant II is powered by a Bristol Mk. 2 solid propellant motor and reaches altitudes of about 60 mi. Instrumented nose cone collects data from the middle ionosphere. About 15 shots have been made from Ft. Churchill and another 15 are planned. Canadair makes the fuselage and fins.

Defense Research Board also is interested in infrared detection of ICBMs. It helped to set up Operation Outlook with the U. S. National Aeronautics and Space Administration, in which two CF-100s specially fitted with instrumented pods flew from Ascension Island to measure radiation from missiles in flight.

In civil defense, the Board is conducting studies of shock and blast waves and recently set off a blast of 40,000 lb. of TNT to simulate a nuclear explosion. Next August, a controlled blast of 100 tons is planned on an instrumented range. Bell Telephone now is building underground vaults to measure possible damage to cables.

Other programs include research for use of ice as landing platforms and the defense aspects of biological warfare, in conjunction with the U. S. Army Dugway Proving Ground, Utah.

Newest project is construction of five hypersonic launching platforms by the Canadian Armament Research and Development Establishment at Valcartier, Que. Platforms can handle models up to 100 lb. weights and will be used to measure impacts and re-entry forces as related to ICBMs.

On the industrial front, Canadair has beefed up its sales and research in the cargo field in a determined attempt to sell the CL-44D swing-tail in the international market.

Major project, other than the CL-44, is the F-104G production line, just getting under way. Under a separate subcontract, Canadair will build F-104 wings, aft fuselages and empennages for Starfighters being produced by Lockheed for West Germany, Japan, Holland and Belgium.

Cancellation of the delta-wing Avro Arrow jet interceptor after five aircraft were built at a total development cost of $400 million was a blow from which the company has not fully recovered. The aircraft were later scrapped. Its aeronautical work now primarily is on its Flying Saucer, which currently is undergoing wind tunnel tests. Otherwise, Avro is building juke boxes and a machine that packages frozen macaroni.

De Havilland of Canada is concentrating on filling Caribou orders for U. S. Army—five have been delivered and 22 more will be built this year—and eight airplanes, ordered by Ghana air force, go into production in October.

Germans Weld Multi-Nation Defense Team

Bonn—The year 1961 marks a significant turning point in the resurgence of West German military aviation and its supporting industries.

The air force for the first time will be receiving initial quantities of an aircraft that can more than match the MiG-17s of its East German counterpart.

The West German industry for the first time since the era of the Messerschmitt 262 and the close of World War II will be producing top-drawer combat aircraft under license and pushing designs for the future largely of its own making.

Sud Alouette with SS-10 Missiles

West Germany's air force bodes to become the strongest in Western Europe over the next four-to-five years and its industry a leader in design, development and production—all within a decade of its halting re-emergence in early 1956.

Reasons behind such a rapid growth and expansion are varied. They include West Germany's proximity to the Communist border and the threat behind it; a vigorous economy that, better than most in Europe, can absorb the costs such a comeback entails; a technological tradition that can give it substance, and a determination to re-establish the country as a major nation of the West on all levels. Finally, a vital factor has been U.S. aid and encouragement at every step.

West German pilots are now checking out on the Lockheed F-104F two-place trainer, and first deliveries of 96 Mach 2-plus F-104G interceptors on order from the U.S. will begin arriving here this summer. Seven German airframe manufacturers are tooling to participate in the European F-104 production program and hope to roll out the first complete aircraft sometime late this year.

F-104G production and other projects now under way promise to keep the industry at peak effort through 1965. When these programs phase out, West German planners hope to have others, especially VTOLs, ready to follow.

While the need for a high-performance VTOL fighter has been debated on an on-again, off-again basis within U.S. Air Force and industry circles for the past several years, West Germany has been working diligently on such projects since 1958.

Accelerating its push toward a family of VTOL vehicles, the German government recently concluded agreements with France for the joint study and production of a high performance fighter (AW Dec. 26, p. 20) and with Great Britain for the development and production of a light reconnaissance and close support aircraft (AW Jan. 16, p. 36).

Major German effort in this field has been concentrated upon development of a Mach 3 interceptor as an F-104 replacement by a Messerschmitt-Heinkel-Bolkow team that has leaned heavily upon U.S. experience and whose design will incorporate many of the basic features of the now-dormant Bell-188A that had a projected speed of Mach 2-plus.

Envisioned powerplants would be six-eight 5,000-lb. thrust Rolls-Royce RB. 153 turbojet engines now under development in cooperation with Maschinen Fabrik Augsburg-Nurenburg (MAN).

In the close-support field, Focke-Wulf has been studying the possibilities of a tail sitter and Siebelwerke-ATG a more conventional VTOL as potential replacements for the Fiat G.91. These programs, however, could die with the signing of the agreement with Great Britain for development of an aircraft based upon a successor or follow-on to the Hawker P.1127.

German planners also see the need for a VTOL transport as a replacement for the Nord C.160 Transall turboprop to round out the next generation and essentially eliminate reliance upon long runway systems—which invite both aircraft and missile attack—for their combat and support wings.

This plan, however, is still in the embryonic stage.

German preoccupation with wide-ranging VTOL designs surpassing that of most other nations is not surprising in view of German vulnerability to pinpoint attack from relatively short-range Soviet missile systems and East European Yak-25 Flashlight interceptors equipped with long range air-to-air missiles. The latter can remain over their own territory and virtually pick off West German aircraft as they take off from known airfield complexes. VTOLs could be scattered in forest clearings and farmlands, constantly shifting position to make advanced knowledge of their exact whereabouts more difficult and the chances of survival correspondingly greater.

Licensed production, bilateral and multilateral agreements within and outside the formal framework of the North Atlantic Treaty Organization, are providing the practical impetus to the

steady growth of German industry and the air force.

Of all agreements signed thus far, the F-104G is by far the outstanding example.

A controversial decision whose merits are still being debated, the German F-104 production plan has mushroomed to the point where it is providing major —and in some cases life saving—business for the industries of three other European nations—Belgium, The Netherlands and Italy.

Although the European F-104 program could still grow, for the moment a total of 949 airframes are to be built. Of these, 604 are scheduled for West Germany, 125 for Italy, 120 for The Netherlands and 100 for Belgium. The advantages to the other nations joining West Germany in the program are obvious.

Italy, for example, is financing only 75 of its 125 aircraft, with U.S. mutual aid funds carrying the rest. In return, Fiat has been assigned production of 182 airframes, 57 of them for Germany, and will share in components manufacture and final assembly of the F-104's General Electric J79 engine. A major subcontractor to Fiat in the engine field will be Alfa Romeo.

Fiat, and Italy, are receiving an additional boost from the over-all modernization program of the German air force which also is purchasing 50 G.91 R.3 close-support aircraft and 20 trainer versions directly from the Italian firm and has license agreements for the production of another 280 R.3s by West German industry.

In the German G.91 production. Dornier-Werke will have the responsibility for final assembly and manufacture of the center fuselage section; Messerschmitt the forward and rear fuselage sections and Heinkel the wing and tail assembly. First rollout is scheduled for mid-summer.

Klockner-Humbold Deutz, of Foln-Deutz, will build the G.91's Orpheus powerplant under license from Britain's Bristol Siddeley Engines, Ltd.

Prior to the F-104 and G.91, the new West German industry already had cut its teeth on fairly-sophisticated modern airframes. Post-war turbojet powerplant experience, however, has been largely confined to major overhaul and maintenance, with some experience by BMW Triebwerkbau in particular on the design of engines in the near-minimum thrust ranges.

While Klockner can handle the 5,000-lb.-thrust Orpheus, the 15,000-lb.-thrust J79 for the F-104G presents infinitely greater problems. And, Germany is being forced to look even further outside its own borders than it did in its search for F-104 airframe contractors in order to find facilities and competence.

Originally, as the four-nation project was being negotiated last fall, the J79 effort was to have been split evenly between Germany's BMW Triebwerkbau, the Belgian FN Works and Fiat. Subsequently, BMW and Fiat experienced difficulty in finding competent subcontractors with adequate facilities and space on their production lines, and the ratio had to be shifted.

Under present plans, Belgium will get the lion's share—48.26%. Germany will follow with 32.47% and Italy with 19.27%.

In electronics (in dollar values only since much of the work will be subcontracted within the U.S.) Germany will assume responsibility for approximately 44% of the over-all F-104 program, Holland 21%, Italy 19% and Belgium 16%.

As its F-104 program grew in numbers, Germany also found it necessary to throw even more of its internal industry into airframe production.

Initially, and before Italy became a partner, West German industry was organizationally divided into two geographical groupings, with the Southern Group assigned the G.91, F-104 and fighter aircraft generally and the Northern Group concentrating primarily upon heavier types, including transports.

Production needs, however, soon outstripped the capacity of the Southern Group and its Belgian and Dutch partners. The Northern Group, while retaining its entity, was brought in, and there was a realignment of tasks. Still another reshuffle was made last fall when Italy formally entered the picture. Here is the present breakdown on airframes:

- **Southern Group** of Messerschmitt, Heinkel, Dornier and Siebel, 210 airframes for the West German air force. Over-all responsibility rests with Messerschmitt.
- **Northern Group** of Focke-Wulf, Hamburger Flugzeugbau and Weserflugzeugbau joined with Holland's Fokker and Aviolanda in the production of 375 airframes—120 to the Dutch air force, 255 to the German. Team leader is Fokker.
- **Belgium's** Societe Anonyme Belge de Constructions Aeronautiques (SABCA) and Avions Fairey, 182—100 for the Belgians, 82 for Germany.
- **Italy's** Fiat, 182—125 to the Italian air force, 57 to the German.

In its concentration upon strengthening its military potential today and moving toward VTOLs tomorrow, Germany has necessarily had to overlook other segments of the aviation spectrum.

Commercial jet transport plans, for example, have been cast aside for the moment. The last remaining promising prospect, a Mach .9, 70-passenger turbojet planned by Hamburger Flugzeugbau, was abandoned late last year. Company officials complained at the time that plans for the aircraft had gathered dust in government "in" baskets for the past two years awaiting action on Hamburger's bid for official financial support for the aircraft.

In the meantime, U.S. and British designs for competitive transports in the short- and medium-range field approached the hardware stage. Hamburger, which estimated that it would need orders for a minimum of 100 aircraft before putting its transport into production, realized that the time to act had passed it by and withdrew its plans.

Capability and capacity in the area of helicopters are just beginning to bud, although several firms have produced interesting designs in the smaller-capacity category, and the German military is making extensive use of U.S. and French equipment.

Home production is not far away. Weser Flugzeugbau is tooling to build Sikorsky's S-64 flying crane under license. The West German Defense Ministry has recently undertaken an extensive review of its needs, and a tripartite agreement with France and Italy may soon produce some interesting original designs.

Under the tripartite pact, signed without fanfare in November, 1958, Germany has responsibility for the smallest and largest types while France and Italy share the medium-size field. Operation of the pact is just beginning to take final shape and represents still another step in the necessity-inspired move toward more and more common design and production efforts within Europe.

These efforts, stemming primarily from the need for more funds and greater technical skills in the adoption of modern weapon systems than any one nation can supply, are moving the NATO nations more and more into the realm of standardized equipment and provide an example of how necessity can override nationalistic pride.

Within some of the NATO nations now joining common production projects, standardization was almost a vulgar word a few short years ago. Nationalism and mutual mistrust made the use of home produced military equipment a political requirement.

Such ideas are far from dead, but common design and production, with each nation taking nationalistic pride in its share of the work, is becoming more and more common and paved the way for Germany's revival.

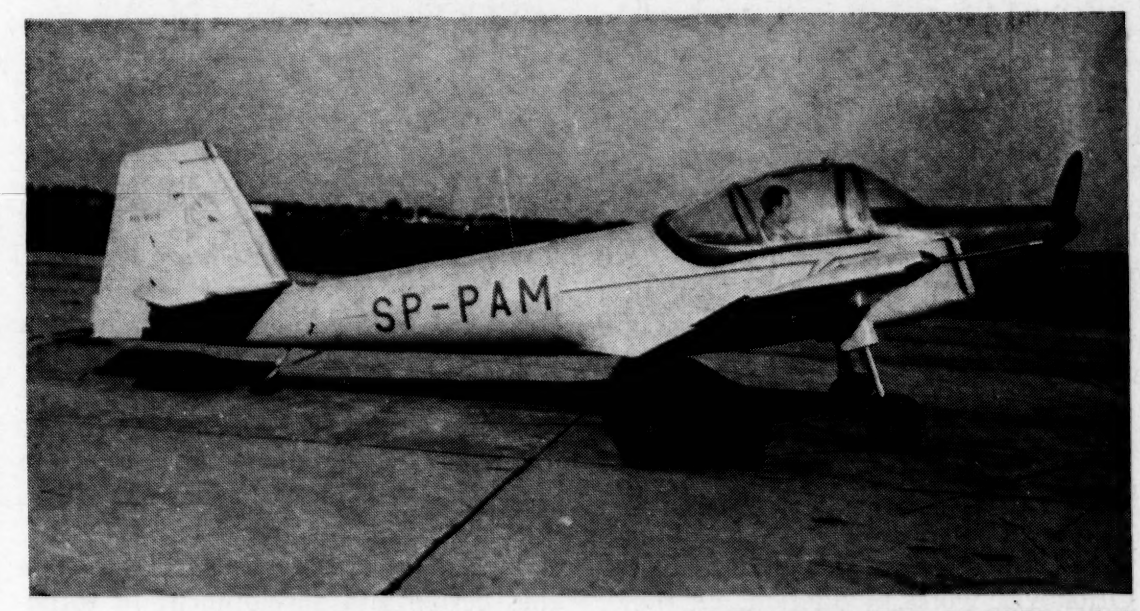
The F-104, G.91, the NATO Hawk anti-aircraft and multi-nation Sidewinder air-to-air missile production efforts, the Transall, the Breguet 1150 ASW aircraft, the VTOL and helicopter pacts with European neighbors are current examples of the impact of common projects on the West German aviation industry and its resurrection.

East Europe Pushes Aircraft Exports

Geneva—East European aviation industry is intensifying its drive to find broader outlets in the West for its widening range of aircraft and related products.

With a steadily increasing capacity within the framework of the post-war Five Year Plans—the third successive one is now beginning in Czechoslovakia—the saturation point has almost arrived among the Eastern bloc partners. This applies generally to all their key industries as well as aviation. New export markets must soon be established, or the over-all economic structure will suffer a setback.

CZECH L-200 MORAVA



PZL-102B KOS SPORTPLANE

The first few post-war years were devoted to rebuilding and realigning a partially destroyed and dormant aircraft industry with technical aid and raw materials supplied by the Soviet Union. After its rebirth, initial production found a ready market within the Soviet bloc, with Russia leading as the satellite countries' main customer for light aircraft.

Production Sharing

Within the Soviet bloc, production in every industrial field has been largely coordinated, with a minimum of competition between any two countries. Here is the breakdown within the aviation industries:

• **Soviet Union** takes care of all large civil transports, military aircraft, missile and space research programs, while its East European associates produce a fairly wide range of light aircraft for training, agriculture, sport and business.

• **Czechoslovakia,** which is continuing production of the Russian-designed Ilyushin Il-14 piston-engine transport and producing to a limited extent the Russian MiG-15, -17 and -19 fighter series as well as the Ilyushin Il-28 bomber, is concentrating primarily on the development of light aircraft and sailplanes.

• **Poland** is making a limited number of sport planes but is concentrating particularly on sailplane design and production for which it has long ago established a reputation. Recent developments in this field include the sleek Zefir (open class) and Foka (standard class) Polish sailplane entries at the Eighth World Gliding Championships last June at Betzweiler, West Germany, where they aroused considerable interest and admiration.

• **East Germany's** contribution to the East European general aircraft production pattern is confined to short-range transport and turbojet development, sailplanes, piston engines and previous production of the Russian Ilyushin Il-14P. The last of a total of about 100 Il-14Ps was completed at the end of 1959 and many of them, powered by the Russian Asch 82T piston engines also built in East Germany, were supplied to Communist China, Bulgaria, Rumania, Hungary and other countries.

Communist China ranks second only to the Soviet Union as a customer for products from Czechoslovakia, the top East European producer. They head a list of 45 nations, including many from the West, who are doing business with the Czechs. Chinese purchases within recent years have included light aircraft, accessories, engines and complete airport installations.

The Czech Ministry of Precision Mechanics, which controls the Czech aircraft industry, claims that Czechoslovakia ranks second among the world's largest producers and exporters of small transport and sport aircraft within the 4,409 lb. gross weight and five-seat capacity range.

Recent industrial trade fairs such as those held annually at Brno, Czechoslovakia; Poznan, Poland, and Leipzig, East Germany, emphasize the efforts being made by the Soviet bloc to increase trade with western countries.

The character of these fairs is becoming more international from year to year, the sections devoted to aircraft larger and the range of exhibits more extensive. Literature distributed is no longer available only in the Soviet bloc languages but in three or four Western ones as well. It is obvious that East European manufacturers are recognizing the unique opportunities these fairs offer to meet and make initial contact with much-needed customers from the West.

Nor have representatives of Omnipol,

Motoimport and Technocommerz, the export organizations responsible to their respective governments in Czechoslovakia, Poland and East Germany for all trade, been slow to realize the value of personal contact with possible customers. Of late, they have been increasing their sales tours throughout the West in search of new markets, and they are meeting with some success.

Omnipol of Prague says that exports of aircraft, including spare parts and accessories, increased 42% in 1958 over 1956, and that the 1959 results boosted this figure 151% over 1956 exports. The 1960 figures are not yet available.

Until recently, the Strojirny Prvni Petiletky Works at Kunovice produced the twin-engine, four-seat touring and multi-purpose Super Aero as well as an improved version, the Aero 145, designed for air taxi or utility missions. Production of the Super Aero series was discontinued last fall. The four- to five-seat L200 Morava series, a small transport and air taxi aircraft designed by Ladislav Smrcek, also is built at Kunovice.

At the Moravan Otrokovice plant, the production program comprises the Z326 Trener Master, a two-seat tandem, low-wing, all-metal aircraft derived from its predecessor, the Z226 Trener Master, designed by Engineer Zamecnik; the HC-102 Heli Baby 130 hp. two-seat, general purpose helicopter; a new six-seat version, the HC-3 helicopter powered by a 240-hp. piston engine, presently undergoing flight tests, and the widely exported motor winch Herkules III.

Sailplanes also are included in the Otrokovice works production. Of these, the L-13 Blanik two-seat tandem glider, for all categories of training from elementary to instrument flying as well as for high performance flight, is probably the most interesting recent development in the series. The prototype Blanik completed its flight tests in March, 1956, and the first 100 to be produced were supplied to Russia.

The Czech Walter Minor 6-HI, M 332 and M 337 series of aero engines also are being produced at Otrokovice.

The Orlican Chocen works is concentrating on the manufacture of the L 40 Meta-Sokol all-metal, low-wing, four-seat monoplane designed for sports flying and touring and the L 60 Brigadyr high-wing, four-seat utility aircraft.

Of the Czech light aircraft now being produced, Omnipol Foreign Trade Corp. says the L 40 Meta-Sokol is the most popular export model. As of late last year, 15 of these had been supplied to West Germany and 11 to Australia. It also has been sold in England, Norway, Finland, Sweden, Denmark, Austria, Poland, Hungary, Iran, Brazil, Argentina, Chile and recently in Spain.

Complete Czech airport lighting installations, first introduced by Omnipol at the 1959 Brno Fair, have since found many customers in Eastern Europe, including Russia where they are installed in nine major airports.

The Czech aircraft industry's target within the latest Five-Year production program specified by the Czech Ministry of Precision Mechanics is:

• **Continue Morava and Trener Master** lightplane as well as L-13 Blanik all-metal sailplane production.

• **Continue development** of a standard type glider and accelerate development of small STOL and VTOL passenger transports and/or cargo versions.

VVB Flugzeugbau with headquarters at Pirna/Elbe handles over-all administration of the entire East German aircraft industry. (VVB stands for Vereinigung Volkseigener Betriebe—Association of Publicly-owned Aircraft Factories). Current projects include:

• **VEB Flugzeugwerke** at Dresden, principal of the six manufacturing firms, is charged with the development and production of transport aircraft. Production at the moment is concentrated on the second prototype Baade B.B. 152 58-seat transport. First prototype B.B. 152 was lost when it crashed at Dresden on March 4, 1959 (AW Mar. 23, 1959, p. 58). Second prototype B.B. 152 went into production last spring. A smaller twin-jet Type 155 30-passenger transport layout is reported to be under development at Dresden as well as a helicopter or trainer with a Pirna O17 gas turbine.

• **VEB Entwicklungsbau** at Pirna handles design and development of turbojets and small gas turbines for various industrial uses including aircraft. Pirna O14 engines and three gas turbines of the Pirna O17 variety are in production.

• **VEB Industriewerke** at Ludwigsfelde produces turbojet and small marine engines. The Pirna O14 is also being made here.

• **VEB Industriewerke,** Karl-Marx-Stadt, produces and overhauls piston engines and also is charged with development and production of equipment for transport aircraft. Included in the current production program is the manufacture of the Russian Asch 82T piston engine, which began here in 1956.

• **VEB Maschinen-und Apparatebau,** Schkeuditz, develops and manufactures ground equipment for both transport aircraft and airports. Overhaul of transports is done here.

• **VEB Apparatebau,** Lommatzsch, develops and produces gliders and sailplanes. The two-seat tandem Lehrmeister glider for sport and training and the single-seat Libelle high-performance sailplane suitable for contest flying, advanced training and basic aerobatics are both now in series production at the Lommatzsch works. Increasing numbers of East German-built sailplanes are finding markets abroad.

After World War II, purely Polish designs of any shape or form were discouraged, and the industry was required to concentrate on the production of various Russian-designed aircraft.

In recent years, however, production of military types has been drastically reduced in Poland, and the industry has concentrated more upon the license production from Russia of small aircraft of the Yak-12M multi-purpose monoplane variety. Its Polish-designed successor, the PZL-101, was developed by a team headed by Stanislaw Lassota. It is being built by the former Polskie Zaklady Lotnicze Works at Warsaw-Okecie, which was renamed under Russion control W.S.K. Wytwornie Sprzetu Komunikacyjnego. The PZL-101 completed its flight trials in spring 1958 and is available for export in two versions: PZL-101 G-1 designed specifically for agricultural purposes and the PZL-101 G-2 multi-purpose aircraft.

Monoplane Production

The W.S.K Works at Warsaw-Okecie also is producing the PZL-102 Kos single-engined monoplane, which fills the Polish aero clubs' requirement for light aircraft suitable for sport flying and touring. Development of this type began in August, 1957 and the first prototype, powered by a 65-hp. Narkiewicz WN-1 engine, flew in May the following year. A fully aerobatic, more powerful version with an air-cooled 90-hp. Continental C900 engine is now also being produced and is available for export.

A Polish-built version of the Russian-designed Mi-1 two- to three-seat, multi-purpose helicopter, the SM-1/600, is being manufactured by the W.S.K. Works at Swidnik. First Polish production SM-1 model came off the line in spring 1956, and the Polish Air Force has a number of them in service. They also are being exported in quantity to the air forces of some of the other East German countries and Arab states. Several models suitable for ambulance, agricultural and liaison purposes are included in the present SM-1/600 production program at the Swidnik facility.

Various other light fixed and rotary-wing aircraft such as the two-seat jet TS-11 Iskra intended as a replacement for the TS-8 Bies trainer, the four-engined MD-12 developed from the twin-engined Css-12 20-passenger transport, the four-seat BZ-4 Zuk helicopter as well as a number of sailplanes and gliders are known to be in various stages of development or production.

Broader Space Booster Program Urged

By Edward H. Kolcum

Washington—U. S. industry can outstrip Russia in space booster capability by 1966 with 200,000-lb. interplanetary payloads if the nation will sustain a vigorous, top-priority launch vehicle development program, the House Committee on Science and Astronautics was told last week.

Representatives of eight major propulsion companies failed to agree on the optimum vehicle concept, but they were unanimous in the view that the nuclear rocket program must be accelerated, and that definitive action depends on stronger executive leadership than booster efforts have received in the past.

Depth of industry concern over the booster program was reflected in the wide variety of studies now being made, mostly with company funds, which could be advanced with government support. Among them:

• **Rita nuclear-powered transport system,** proposed by Douglas Aircraft Corp., as a reusable interplanetary spacecraft which could be ready within 10 yr.

• **High-pressure hydrogen-oxygen** rocket, developed and being evaluated by Pratt & Whitney. It would be about the same size as the LR115 Centaur engine envelope, but performance would be improved to the point where, used in an upper stage, it could accelerate 100,000-200,000 lb. payloads to escape velocities by 1966-67. First engines could be available in 2-3 yr.

• **Conical segmented solids,** developed by United Technology Corp., which could deliver 2-million-lb. thrust or more by 1964, if the program received $150-200 million in funds.

• **Uprated Atlas to form** the booster stage of an Atlas-G Centaur vehicle, able to orbit 24,000 lb., compared with 8,500-lb. for the first Centaur. James R. Dempsey, General Dynamics vice president and manager of Convair-Astronautics, said a company proposal to uprate the Atlas, not as a weapon but as a space booster, was not accepted by the Air Force. He also said Saturn C-2 development is not keeping pace with the Dyna-Soar development schedule, and a new booster may be needed to launch the Dyna-Soar glider, which Dempsey said will weigh 11,500 lb. Titan II launch vehicle earmarked for the Dyna-Soar program can only put 8,000 lb. in an 80-mi. orbit, he said.

• **Minuteman family of launch vehicles,** based on Thiokol Chemical Corp. XM-55 solid fuel first stage for the USAF Minuteman missile. Family would consist of four vehicles, one a four-stage clustered arrangement able immediately to put 25,000 lb. in orbit. Most advanced version, used with nuclear and chemical upper stages, could orbit 2.1 million lb. in the 1970 period, Thiokol maintains.

Concurrent research and development approach in the nuclear rocket program could be followed by the Rita nuclear-powered transport system, described to the space committee by R. L. Johnson, chief engineer of Douglas' Missile and Space Systems group.

Rita-A would be a single stage vehicle, either launched by the Saturn S-1 booster or by itself as a single stage. A semi-ballistic re-entry configuration, it would be designed to orbit 15,000 lb. when used as a single stage and 85,000 lb. as second stage, and to put 10,000 lb. on the moon without refueling.

Rita-B, much larger but the same shape as the -A version, would be used as a single stage to orbit 160,000 lb. It could put 25,000 lb. on the moon without refueling, and make interplanetary flights with multiple refueling and a 45,000-lb. payload.

Anticipated performance improvement of the high-pressure hydrogen-oxygen engine is encouraging enough to believe it could orbit a sizable payload as a single stage launch vehicle, according to Walter Doll, chief engineer of United Aircraft Corp.'s Pratt & Whitney Division. The 100,000-200,000-lb. payloads would be launched with a segmented cluster of United Technology solid rockets as first stage, and the advanced hydrogen-oxygen engines as second stage. United Technology is a subsidiary of United Aircraft.

Hearings on the booster programs began late last month (AW Mar. 6, p. 29) with government and industry statements on the Rover nuclear rocket program. These hearings were continued last week concurrently with hearings on space propulsion technology. Committee Chairman Overton Brooks (D.-La.) said he will schedule hearings on the national booster program next month.

Consensus among the industry witnesses, who commented on the need for an integrated program for military and civilian launch vehicles, was that such a program is necessary in the research and development area, but not in operation and should not be managed by a single agency.

Agreement also was evident among the industry spokesmen that Rover development must be initiated without delay. Nuclear rocket system, some officials feel, could be flown as early as 1965 if funding were consistent and long-range.

Dyna-Soar Outlook

Washington—Proponents of an accelerated research and development program for USAF's Dyna-Soar boost glider do not expect any major increase in funds before Fiscal 1963, even if shortened timetables are approved in the current reviews of defense projects.

No interim booster has yet been chosen for orbital research flights of the glider. Titan II and Atlas-Centaur have been proposed, but neither can do the job without modification of its second stage. Other proposals have included a Titan first stage, plus a Centaur upper stage; a Phoenix-type of booster in the 800,000 to 1-million-lb. thrust class, possibly consisting of two Rocketdyne E-1 engines; some new recoverable booster; the 1.5-million-lb. thrust Saturn. The modified Minuteman second stage that will be used with the Titan II for suborbital research shots will serve as an escape rocket and is not intended to boost the glider to orbital velocity.

Weight of the research glider originally was to have been 9,000 to 10,000 lb. Weight gained during the design stage brought it almost to 11,500 lb., but design refinements now have reduced it almost to the 10,000-lb. mark. Although Saturn or a booster in that thrust class would be needed to orbit a Dyna-Soar weapon system, project engineers consider it unnecessarily large for orbital flights of the research glider.

Pan American Ordered To Sell Panagra Stock

Washington—Pan American World Airways has been ordered by a federal court to divest itself of its 50% ownership in Pan American Grace Airways. Dismissing the Justice Department's anti-trust charges against Panagra itself and against W. R. Grace & Co., which owns the other half of Panagra's stock, Judge Thomas S. Murphy found that Pan American's ownership affects freedom of competition and trade. He noted that Pan American's half interest in Panagra was worth about 4.5% of its net income in 1959.

USAF Given Larger Space Role As Defense Consolidates Program

Washington—Defense Department last week made Air Force its agent for all space development programs "except under unusual circumstances" and tightened control over the number of projects that will be allowed to advance beyond the preliminary research stage.

Defense Secretary Robert S. McNamara signed a directive (No. 5160.32) giving USAF the broader development role and requiring review by the director of defense research and engineering and specific approval by McNamara or Deputy Secretary Roswell Gilpatric before any project moves into the research and development phase.

Once this approval is given, USAF assumes responsibility for research, development, test and engineering. Exceptions to this will be made "only in unusual circumstances," even though Navy or Army may have originated the project.

The directive, first reported by AVIATION WEEK (Mar. 6, p. 26), increases USAF's almost complete hold on military space as far as the three services are concerned, but at the same time strengthened the hands of Defense's research director and the secretary of defense in controlling and directing the size and scope of the military space program.

This follows a recommendation of the Wiesner task force report to President Kennedy (AW Jan. 16, p. 26 and Jan. 23, p. 79), which said:

"Each of the military services has begun to create its own independent space program. This presents the problem of overlapping programs and duplication of the work of National Aeronautics and Space Administration.

"If the responsibility of all military space developments were to be assigned to one agency or military service within the Department of Defense, the secretary of defense would then be able to maintain control of the scope and direction of the program and the [National Aeronautics and] Space Council and would have the responsibility for settling conflicts of interest between NASA and the Department of Defense."

Defense Department spokesmen said the directive resulted from the Wiesner recommendation, reviews conducted since McNamara took office, and "operational experience" since Jan. 20 which indicated that military space responsibilities were "not clearly delineated and delimited."

USAF already had responsibility to develop, produce and launch space boosters and to integrate its boosters with payloads developed by the other services.

The new directive now gives it responsibility for everything beyond preliminary research and up to operational deployment on future—but not existing—projects.

A memorandum from McNamara to Defense and service chiefs which was published with the directive said assignment of operational responsibilities is not predetermined by which service performs the development work, and will be made "on a project by project basis as a particular project approaches the operational stage, and . . . will take into account the competence and experience of each of the services and the unified and specified commands."

Defense spokesmen refused to say whether a joint operational space command is a likely follow-on to the assignment of development responsibility to USAF, but the recent Air Force Space Study Committee report recommends such a step.

The directive states that the scope of preliminary space research done by any service "shall be defined by the director of defense research and engineering in terms of expenditure limitations and other appropriate conditions."

Each service will be given limited amounts for such feasibility studies. Amounts have not been determined, nor have the ground rules been developed for exactly what work must have the research director's specific approval in the phases that precede actual research and development.

The directive was drawn by the Office of Organization and Management Planning, created recently by McNamara under the defense general counsel's office. Service secretaries and the Joint Chiefs of Staff offered their opinions on a draft version before the final version was signed.

McNamara and Gilpatric said that the method—review, allow comment and then make a decision—and the specific tool used, the management office, illustrate the manner in which they propose to administer and operate the Defense Department.

FAA Responds to Senate Demands

Washington—Senate Aviation Subcommittee demands for greater federal concentration upon the problems of air safety were reflected last week in a series of initial steps the Federal Aviation Agency is taking to make flying safer.

Najeeb E. Halaby, new FAA administrator, said the agency is taking the following steps to improve the safety record as a direct result of Civil Aeronautics Board and congressional investigations of the midair collision between a Trans World Airlines Super Constellation and a United Air Lines DC-8 over New York last December:

- **FAA has called a meeting** this week with manufacturers of distance measuring equipment and will decide later this month whether to make installation mandatory on jets.
- **Lower entry speeds** for aircraft approaching holding patterns are being considered by FAA.
- **Study of air traffic** controller working conditions is being accelerated.
- **Frequencies and identification** abbreviations of radio check points are being reviewed to eliminate any confusion because of their similarity with other points.

Each of the steps cited by FAA was strongly recommended by the Senate subcommittee, which ended its hearings on air safety last week with a plea that FAA, CAB and the airlines make a maximum effort to reduce the industry's fatality rate through more efficient use of existing authority and equipment.

Pending possible construction of more airports to handle the traffic flow in high density areas, Sen. A. S. Mike Monroney, chairman of the subcommittee, suggested that airlines cut back their schedules. His observations met with strong objections from the Air Transport Assn., which said it favors handling the problem by improving the present air traffic control system. ATA added that whenever its member airlines did reduce schedules, a general rise in non-commercial aviation traffic was noted at the terminal.

Sen. Monroney also told members of the Air Traffic Controllers Assn. that if the FAA does not submit legislation to Congress soon on the status of air traffic controllers during wartime, he will personally offer bills spelling out their personnel rights during and after military service.

Such legislation was called for shortly after Federal Aviation Agency was established, but it has not yet been submitted to Congress.

During the hearings, the Flight Engineers International Assn. called for uniform design in aircraft cockpits to relieve pilots from performing engineering duties and charged that economic pressures on the airlines have resulted in different designs, which affect crew assignment duties.

Showdown Expected On Nuclear Aircraft

Washington—Showdown on the future of the aircraft nuclear propulsion program is expected during a session of the Joint Congressional Atomic Energy Committee this week at which top Defense Department and AEC officials will be witnesses.

After a briefing session last week with technical representatives of General Electric Co. and the Pratt & Whitney Division of United Aircraft Corp., Rep. Chet Holifield (D.-Calif.), chairman of the committee, and Rep. Melvin Price (D.-Ill.), chairman of the research and development subcommittee, repeated their position that it will take "at least two years" before a proper technical decision can be made as to whether the General Electric direct-cycle or the Pratt & Whitney indirect-cycle offers the better approach to nuclear aircraft propulsion.

The congressmen said that meanwhile they want research and development on both approaches to continue, particularly on the more advanced GE project which offers the prospect for early flight and the international prestige that will result.

In January, President Eisenhower called for one approach only and reduced funds for Fiscal 1962 to $68 million from the $150 million a year that has been allocated to the program over the past several years (AW Jan. 23, p. 28)

Kennedy Group Will Study Aviation Goals

Washington—President Kennedy has created a top-level task force to recommend national aviation goals for the next decade.

The group, which will be headed by Fred M. Glass, will study "the technical, economic and military objectives of the U.S. government throughout the broad spectrum of aviation." The announcement was made by the President during the swearing-in ceremonies of N. E. Halaby as FAA administrator, whom the White House described as ". . . the principal aviation adviser to the President. . . ."

President Kennedy outlined the purposes of the study, which will be called Project Horizon, in a letter to Halaby, stating that the definition of goals is "essential if the agencies of the executive branch are to work effectively together and with the Congress toward common objectives and if the U.S. is to have a safe, efficient, and economical national aviation system."

The task force study will not include military combat activities, but will encompass all aviation operations and facilities serving civil and military needs.

Glass is executive vice president of the Empire State Building Corp. Previously, he was director of aviation for the Port of New York Authority, president of Air Cargo, Inc., traffic vice president for Capital Airlines, counsel for American Airlines and an attorney with the Civil Aeronautics Board.

New Stage Studied For Saturn Vehicle

Cluster of six Pratt & Whitney LR115 engines, each developing 15,000-lb. thrust, is being studied as a possible upper stage powerplant system for the Saturn vehicle.

National Aeronautics and Space Administration said the study does not result from delays in development of the LR119 engine, but is to explore means of increasing upper stage thrust levels. A cluster of four 17,500-lb. thrust LR119 engines will make up the S-4 stage of the Saturn. Both 115 and 119 use liquid hydrogen and liquid oxygen.

Soviets Lose Contact With Venus Probe

Washington—Soviet Union lost radio contact with its Venus probe after it had traveled approximately 4 million mi. Last transmission was received Feb. 27, 15 days after the 1,418-lb. vehicle was launched from Sputnik VIII.

If Russian scientists are unable to reestablish contact with the probe, they will have failed to test feasibility of transmitting over interplanetary ranges, one of the major goals of the launch. U. S. Pioneer V probe, launched a year ago, transmitted data 138.9 hr. over distances up to 22.5 million mi.

National Aeronautics and Space Administration, in its last biweekly satellite situation report, recorded changes in the probe's solar orbital elements from those given a few days after it was launched. Period now is 300 days, compared with the original 288 days. Aphelion is 94.7 million mi., and perihelion, 66.7 million mi. Originally, these elements were 93.5 and 49.8 million mi.

NATO Rules Against V/STOL Alterations

Paris—North Atlantic Treaty Organization requirements subcommittee has ruled against proposed changes in the bid specifications for a NATO V/STOL close-support fighter that would have stipulated "on-the-deck" supersonic performance.

Present specifications require an "on-the-deck" speed of approximately Mach 0.92, and some quarters have been requesting a change to fit more closely with the expected supersonic performance proposals incorporated in the designs of several expected bidders (AW Jan. 9, p. 34). Subcommittee, however, ruled at a recent meeting here to leave the specifications unchanged in order to avoid delays such a move might cause.

Instead, a covering letter from H. G. Bloss, head of the aircraft section of NATO's production and logistics division, probably will be enclosed with the bid invitation emphasizing that any additional performance beyond the specifications will be welcomed.

First Titan Silo Test Made at Vandenberg

Air Force-Martin Titan I missile was fired in a silo last week for the first time. The experiment was designed to test facility design, especially acoustics.

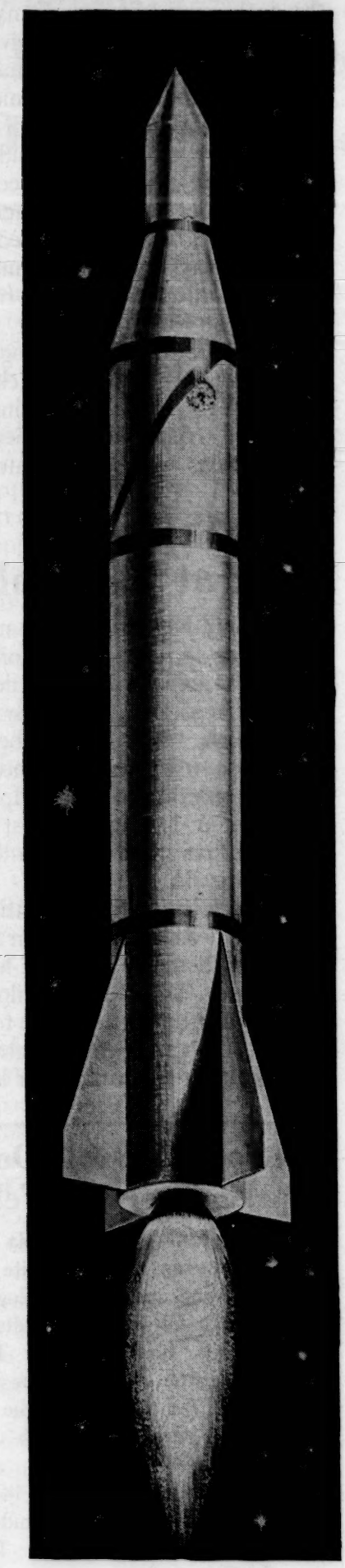
Although the Vandenberg AFB, Calif., silo used was designed for the Titan II storable fuel ICBM, a Titan I was used in last week's test to study effects of first stage firing on the missile and on the silo.

For the captive run, a routine engine shutdown was performed on the Aerojet-General engine after it had run a few seconds. The Titan II silo is 146-ft. deep, compared with 165 ft. for Titan I silos, which contain an elevator to raise the missile to the surface for launching.

Soviets Orbit Dog, Recover it Safely

Washington—Soviet Russia orbited another five-ton earth satellite and recovered a dog and other biological subjects from it last week, according to announcements from Moscow. This was the ninth earth satellite to be launched by Russia, the fourth in the five-ton "spaceship" class intended to carry human passengers eventually, and the fourth to carry some form of life.

Sputnik IX was launched and the animals recovered on Mar. 9. The dog, named Chernushka, was reported in normal condition. Initial announcements were not clear on whether a small capsule, a larger cabin or the entire spaceship was recovered. The Soviet news agency Tass said "the experimental spaceship satellite made a landing in the required area" of the Soviet Union, and also mentioned "the landed vessel" contained the animals. When Sputnik V was launched last August, Russia claimed recovery of both an animal capsule and a larger cabin from which it had been expelled, and said no attempt was made to recover an instrument section of the spaceship.



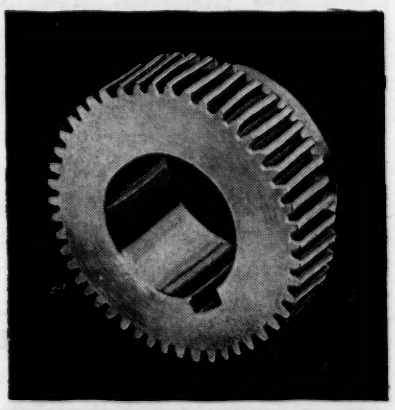
GEAR ACCURACIES IN SECONDS TO GOVERN MILLION MILE FLIGHTS

When Gears of almost unbelievable accuracy are required for America's newest giant missiles designers naturally call upon Equitable Engineering. The nation's leading industries have learned to depend upon Equitable to meet their toughest problems wherever the finest, most exquisite perfection is called for in gears.

- Gears rolling together within 50 millionths of an inch total composite error, as determined by electronic checking equipment.
- Design and production of complete, high precision gear trains guaranteeing input to output accuracies *in seconds.*
- Gear and splined parts from 2 to 200 diametral pitch.

Are you experiencing an accuracy problem? Then write, wire or phone Equitable from wherever you are, today!

Member: American Gear Manufacturers' Association



EQUITABLE
ENGINEERING COMPANY
2724 NORMANDY ROAD • ROYAL OAK, MICH.
PHONE LIBERTY 9-5300

Circle Number 306 on Reader-Service Card

CAB Shift Emphasizes International Activity

Washington—Elevation of the Civil Aeronautics Board's international staff from the division level to bureau status underscores the increased emphasis the Board will place on bilateral air transport agreement negotiations.

Under a wide-scale reorganization plan, CAB Chairman Alan S. Boyd has eliminated the Bureau of Air Operations and replaced it with a Bureau of International Affairs and a Bureau of Economic Regulation. The latter bureau will be headed by Irving Roth, an associate director of the former Bureau of Air Operations. International Affairs Bureau will be headed by Joseph C. Watson, also a former associate director of BAO.

The new reorganization pattern strengthens the role of CAB Executive Director Morris Chertkov by giving him two new offices—plans and administration. Chertkov, who has been with the Board since 1947, will be assisted by Robert C. Lester, formerly Board secretary, who will head the new Plans Office. His counterpart, director of the new Administration Office, had not been named late last week.

The Bureau of Economic Regulation will be divided into three sections: routes and agreements, subsidy and rates. Routes and agreements is a combination of two BAO divisions—routes and special authorities—and will be under the direction of Jacob Rosenthal. Alfred Stout will head the rates division, and Harry Schneider has been named chief of the subsidy division.

John Adams will become director of the Bureau of Enforcement, and John Dregge has the new job of director of community relations.

Symington Says USAF Abuses Flight Pay

Washington—Sen. Stuart Symington (D.-Mo.) criticized the Air Force in a Senate speech last week for spending an estimated $183 million during the current fiscal year on proficiency flight pay for officers who have little or no reason to maintain their flying proficiency.

Noting a General Accounting Office finding that 27,000 out of the 72,000 USAF officers receiving flight pay are either excess to USAF's requirement for flying officers or in assignments which do not require current flying skill, Symington commented:

"Among the 27,000 are officers serving in budget, motion picture, food, fuel, and electronic data processing services, and as lawyers, dentists, auditors, chaplains, mathematicians, physicists, and chemists . . . Many

officers receiving flying pay have not actually flown planes themselves for years. In such cases, subordinates do the flying while the officer in question works or rests in the back of the plane."

Of the $183 million, $71 million is for actual flight pay and $112 million for maintenance and operation of the aircraft.

Sen. Symington's attack on USAF flight pay was one of a series of speeches criticizing waste and mismanagement in the Defense Department and calling for a thorough reorganization. The Kennedy Administration has taken no action on his proposal for reorganization of the Defense establishment, including abolition of the individual service secretaries (AW Dec. 12, p. 34).

General Accounting Office investigations, Symington said, show "the inevitable waste and mismanagement which result when an organization is rooted in the traditions of the pre-nuclear-space age."

Sen. Symington also has accused the Navy of spending over $600 million for aircraft and equipment "which was incapable of performing the designated missions." He said this included procurement of F7U aircraft, $417.2 million; procurement of T2V aircraft, $139 million; procurement of radar for P5M aircraft, $51.6 million; and procurement of excess engines, $68 million.

Future Forces Traded For Navy Readiness

Washington—Future capabilities of the Navy and Marine Corps have been "slowly and reluctantly" traded for present readiness over the past three years, Navy Secretary John B. Connally told the House Armed Services Committee last week.

The Navy is moving into the age of missiles, nuclear power and "very expensive" space projects without any appreciable change in funding levels, he said. The Polaris ballistic missile submarine system, for example, has required about 10% of the Navy's annual budget for the last three years, and the percentage will increase in the future. It will also absorb increasing numbers of highly trained officers and enlisted men in technical areas where the Navy is already desperately short, he said.

To cover the increased costs of other complex weapons systems, including air defense, anti-submarine and aircraft attack systems, Connally said the Navy has been forced to procure fewer ships and aircraft, which means that in future years there will be no replacement of ships and aircraft now nearing obsolescence.

The Navy is not yet in serious difficulty, Connally said, but it cannot postpone the solution to this problem any more. Soviet and Communist satellite forces are increasing in numbers, capabilities and in modernization of equipment and weapons, and the United States must be ready to meet them, the Navy secretary told the committee.

Adm. Arleigh A. Burke, chief of naval operations, told the committee that the Soviets now have in operation a number of submarines believed capable of launching ballistic missiles and that it is almost certain the Soviet Union is actively engaged in a nuclear submarine construction program. A Soviet version of the Navy's Polaris firing submarine must be expected in the near future, he said.

The Russians have more than 400 submarines, nearly 200 destroyer-type ships, and about 25 cruisers, and they are currently building guided missile destroyers carrying surface-to-surface missiles, small anti-submarine warfare and mine vessels and motor patrol craft equipped with missiles.

Air Force Considers Missile Base Czar

Washington—Air Force is considering appointment of a czar to direct its ICBM base construction program, a move urged by the House Appropriations Committee.

The committee's recommendation was the outgrowth of hearings before a subcommittee, headed by Rep. Harry Sheppard (D.-Calif.), at which construction contractors complained that Air Force has harrassed them with endless design changes and delays in decision-making (AW Mar. 6, p. 30). The contractors have already made claims against the government totalling over $116 million over their original contract bids.

Air Force explained at the hearings that the changes resulted from its plan of proceeding concurrently with the construction of the missile bases and the development and production of the missiles. The Appropriations report commented that it "is not at all certain that the Department of the Air Force and its contractors are not using the concurrency requirement to cover mistakes in design that should never have been made."

A new missile base czar, the committee said, "should be charged with the full responsibility for the successful prosecution of this program and given complete authority to fulfill this responsibility. The effectiveness of this type of organization has been clearly demonstrated by the Special Projects Office of the Navy which developed the fleet ballistic missile weapon system and placed the Polaris missile in the arsenal of the free world."

The committee directed USAF Secretary Eugene Zuckert to make "a full and detailed report" on actions taken to improve management of missile base construction before hearings start, in about a month, on Fiscal 1962 funds for the program.

Subsequently, Zuckert said that USAF "is taking action" and that "steps under consideration involve organizational and procedural changes and measures to expedite settlement of valid and proper claims of contractors." He called the base program "one of real accomplishment," noting that although there will be some slippage in the early Atlas and Titan sites, construction of the later sites should be on schedule.

He anticipated a reduction in change orders as USAF moves into construction of Titan II and Minuteman base systems.

News Digest

Dr. Harold Brown, director of the Atomic Energy Commission-University of California Lawrence Radiation Laboratory, was nominated by President Kennedy last week to succeed Dr. Herbert F. York as Director of Defense Research and Engineering. Dr. Brown, 33, a specialist in nuclear physics, reactor design, nuclear explosions and weapon systems, has served on science advisory committees to the secretary of defense and the President and on the Air Force Space Study Committee (AW Jan. 23, p. 33).

Robert T. Murphy was confirmed by the Senate last week as a member of the Civil Aeronautics Board, replacing John S. Bragdon. Murphy is a former special counsel for the Senate Interstate and Foreign Commerce Committee.

Air traffic control study group was established by President Kennedy last week to develop a "well conceived plan for managing air traffic, now and in the future." Task force will be headed by Richard R. Hough, who will report on the study within the next two months to Federal Aviation Agency chief Najeeb E. Halaby.

Grumman has a $38-million Navy contract for continued production of the W2F-1 early-warning carrier aircraft, powered by two Allison T56-A8 turboprop engines.

Joseph S. Imirie, Carborundum Co. vice president, will be named assistant Air Force secretary (materiel). He was

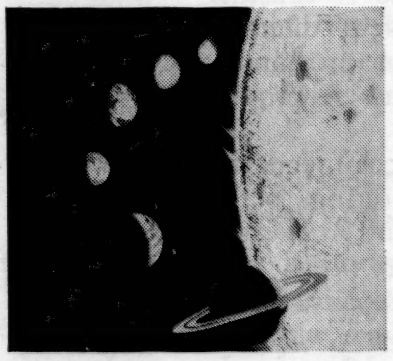
special assistant to the Air Force under secretary from 1948 to 1951.

Ryan Aerospace Division will receive funding of under $100,000 from the Army for support of forthcoming manned flight test of the Rogallo flexible wing glider (AW Feb. 6, p. 35). As a helicopter-towed glider, Army estimates that Rogallo glider may be able to carry six times the payload a helicopter could carry by itself.

W. L. Maxson Corp. has been chosen as the second production source for Navy-Martin Bullpup air-to-surface missile, which will be used by the Air Force as well as the Navy.

North American X-15 piloted by Maj. Robert White set a speed record for manned flight by reaching 2,905 mph. (Mach 4.43) at an altitude of 76,160 ft. Mar. 7 over Silver Lake, near Edwards AFB, Calif. The No. 2 X-15 was powered by an XLR-99, 57,000-lb.-thrust engine which was shut down after 125 sec. of engine burning time. Purpose of the flight was to obtain temperature, stability and control data. Maximum temperature of inside skin on the wing was 675F. Maximum altitude was 77,000 ft.

NEW OPPORTUNITIES FOR ENGINEERS AND SCIENTISTS DEEPLY INTERESTED IN OUTER SPACE



North American Aviation's new Space and Information Systems Division (formerly Missile Division) is extending its capabilities toward the eventual conquest of space. To do this it is necessary to staff the important projects now under way with scientists and senior engineers in the disciplines of electronics; physics; nuclear, electrical and chemical propulsion; flight simulation technology, radiation physics, plasma theory, astro physics, lunar geology; communication theory; information processing, and many more. These men should have one thing in common—an intense curiosity about, and an innate interest in any of the yet unexplored workings of the universe.

The role and mission of Space and Information Systems Division is to aggressively extend its capabilities into any phase of research, systems management or production as required in the nation's developing space program. One of man's chief dangers is to allow himself to become so caught up with what is happening to him today that he gives no thought to what might be happening to him tomorrow. A moment's time taken to address a resume or letter of inquiry to Employment Services, 12214 Lakewood Boulevard, Downey, California, may lead to the most exciting and rewarding phase of your career yet presented.

SPACE AND INFORMATION SYSTEMS DIVISION
North American Aviation

Two contractors to be selected from among a 21-company competition for the Army's light observation helicopter (LOH) (AW Mar. 6, p. 26) will build seven aircraft each. Army expects procurement of production models of one of these two LOH types to be funded in Fiscal 1964. By 1970 it will have 3,000 LOH, according to Maj. Gen. R. D. Meyer, Army Office of Chief of Transportation.

SFERMA, subsidiary of Sud Aviation, has begun flight tests with Dornier Do.27 retrofitted with a Turbomeca Astazou turboprop engine of 440 hp. plus 66 lb. residual thrust. German STOL aircraft normally is powered with 275-hp. Lycoming piston engine. Do.27 retrofit is being carried out by SFERMA under a program financed by Turbomeca.

Boeing B-52H equipped with Pratt & Whitney TF-33 turbofan engines made its first flight last week from McConnell AFB, Wichita, Kan., grossing 330,000 lb. and taking off within 5,000 ft. of runway, using 70% power.

Convair, General Electric and Martin teams briefed National Aeronautics and Space Administration on their Project Apollo efforts Mar. 2-3 in a mid-term review of feasibility studies.

Chance Vought Astronautics Division has a $2.25-million National Aeronautics and Space Administration contract to construct 42 tanks for five Saturn boosters (AW Feb. 13, p. 33), and delivery is to begin in April, 1962. Lockheed Georgia Division has a $335,000 contract for Saturn booster pressure and functional checkout equipment, with delivery scheduled by July 1.

National Aeronautics and Space Administration's top headquarters and field staffs met last week for the first time with James E. Webb, the new administrator, at Luray Caverns, Va. Similar conferences had previously been held periodically at Williamsburg, Va.

Hughes Aircraft Co. has a contract to provide technical assistance to the Martin Co. in activating a Titan ICBM base at Mountain Home AFB, Idaho.

Max Hymans, honorary chairman of Air France's board of directors, died last week in Paris after a brief illness.

Navy has found the pilots of a Brazilian REAL Airlines DC-3 and a U. S. Navy R6D transport did not cause the Feb. 25, 1960, midair collision over Rio de Janeiro that killed 61 persons. The report blamed inadequacy of navigational aids, imprecise methods of traffic control, weather and errors in judgment by the air traffic controller.